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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Telephone: Central 1895. Telegrams: CIRA.
The B.C.I.R.A. Scottish Laboratories are:—
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Forthcoming Events.

MAY 4 and 5.

Iron and Steel Institute:—Annual meeting in London.

Institute of British Foundrymen.

JUNE 20-23.

Institute of British Foundrymen:—Annual conference in Cardiff.

Fuel Oil Tax.

One penny per gallon tax on fuel oil does not seem very important until analysed. The first piece of arithmetic shows it to be £1 a ton, when a simple extension shows that if the melting ratio be 1 to 10, then, taking the delivered price of fuel oil to be in the region of 6s. for 2 cwts. or per ton of metal melted, then in future, if the proposed tax is sanctioned by Parliament, the price will be 8s. or an increase of 33 per cent. on melting costs. Now it was stated that the tax has been proposed in order that the coal industry may benefit. So far as the non-ferrous foundry industry is concerned, we state, categorically, that the furnaces will not be changed to burn coal or any of its derivatives. It merely means that these manufacturing concerns will pay several hundred pounds a year as a direct charge on their manufacturing costs. The new tax, if accepted, may tend to arrest the development of oil-fired furnaces and cause the manufacturers of burners, castings, refractories, tubes and tanks to have smaller order-books. It may to some extent arrest the development of the oil engine, as loss of business in the home market impairs competitive power in the export business. We understand that this has actually happened in Germany. If the coal trade does get back half-a-million tons, the foundry industry will gain but few orders from such an increase. Naturally, there would be something in the direction of colliery-tub wheels, rope pulleys and other equipment, but whether this would be counterbalanced by the loss of the oil engines and oil-burning-equipment business it is difficult to say. So far as the foundry industry is concerned, it will have to find the bulk of the £275,000 which the metal trades will have to furnish if the proposed tax becomes law.

It might be said that this will increase the price of non-ferrous castings by but a fraction of a penny per lb., and is, therefore, without effect. This is not so, as it is just one of those costs which cannot be passed on to the customer, and involves an extra cost to the manufacturer of from tens to hundreds of pounds. Moreover, it is penalising the very firms which have endeavoured to modernise themselves.

Turning to the ironfoundry industry, the proposed tax has two effects. One is in the enamelling department, where, once again on commercial grounds, there will be no change, but technical aspects will operate as usual. The second is in connection with the newer types of rotary melting furnaces, where it is in competition with particularly economical furnaces using pulverised fuel. As the oil-fired rotary furnace for iron melting is a newcomer, it seems desirable that industry should have a real opportunity of trying out its technical merits before handicapping it with higher-running costs.

We are aware that the proposed duties will affect very profoundly other industries. Fishing vessels have already been exempted, and there are excellent reasons for claiming similar conditions for melting plants. Generally speaking, technical advances have accrued to the foundry industry through the adoption of oil as a fuel, and any attempt to impede this development is retrograde and should be resisted. The metal trades can ill-afford an extra £275,000 a year as a manufacturing charge.

Exhibition Impressions.

We have had occasion to mention critically of some Foundry Exhibitions that have been held in the past few years that they did not embody much in the way of new developments. This cannot be said of the Exhibition which has just closed in London. The amount of new material shown appears to have been in inverse proportion to the size of the Exhibition. The number of exhibitors was not large, but the quality was as high as any we can recall.

This applies to metallurgical developments, to machinery and plant, and supply material. The number of developments in special irons and their application is becoming really impressive, and evidence accumulates almost daily of their superiority in service. The development in plant and equipment covers moulding machines, core-making machines, cupola plant and other types of melting furnaces, including the humble crucible furnace. In supply material we have new developments in pig-iron, sands and refractories, facings, and, last but by no means least, in foundry coke. The same remarks also apply to methods of testing and control.

It is fair to conclude that these are signs that the equipment and supply side of the industry is alive and energetic and is wholeheartedly placing its services at the disposal of the industry in meeting conditions of the times. It implies that the industry is availing itself of these developments and is strengthening its position both absolutely and relatively with respect to its competitors.

We cannot conclude without voicing the remarks of many visitors in appreciation of the technical exhibits of the Institute of British Foundrymen and the British Cast Iron Research Association. The exhibits are non-commercial in so far as neither body can look to direct returns, and yet the exhibits were only got together and shown with the aid of a good deal of expenditure of time and labour by enthusiasts. It is sufficient to say here that the exhibits excited a good deal of interest and were studied by many visitors with close attention. We do not think it is sufficiently generally recognised how recently these scientific and technical exhibits have grown as part of the modern exhibition, and conclude

that here again the founding industry has given other exhibitions a lead. There is no doubt that they serve a very useful purpose and emphasise in another way the service which it is now the principal aim of any organisation to furnish its clients. Concrete evidence was available of its appeal when about 20 foundry firms and executive officers were actually enrolled to the membership as a result of their appreciation of the work which the Institute was doing for the foundry industry as exemplified by the Technical Exhibit.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Foundry Education.

To the Editor of The Foundry Trade Journal.

Sir,—I have read with interest the articles which have appeared from time to time in The Foundry Trade Journal on the subject of Foundry Education. The foundry industry is undoubtedly the worst equipped for the training of the mass of its workers, and it seems very probable that, at a not very future date, the supply of skilled moulders will drop dangerously low. There are two factors which tend to reduce the number of young apprentices entering the foundry industry.

Firstly, there is no well-organised system of training, or, where this does exist, it is but scarcely encouraged.

In the majority of industries, individual concerns have organised their own methods of training. A high standard is set, and the young apprentice's progress is related directly to his ability and industry at his work; a progress measured largely by periodical exams. Compare this to the system, where it exists, of night classes in foundry practice. These classes, excellent as they are and practical in their scope, are of little help to the moulder-apprentice. He returns to the "sand heap" full of ideas which he is in no way encouraged to use, and before long is working on the same conservative lines as have been used for generations.

Secondly, the excessive specialisation of labour, caused by the ever-increasing mechanisation of this industry, is producing a type of worker who is apt to become merely a "machine tender." Machine tending is congenial employment compared to moulding. Little brainwork is called for, working conditions are superior, and it is natural that those branches of the foundry trade which are mechanised should attract more young labour than the "moulding side." The repetitive nature of the work lessens initiative and adaptability, and the simplicity of each operation enables youths to be employed in the place of men.

It is clear, then, that there is not sufficient inducement for the right type of young apprentice to enter the trade as "moulders." How can this state of affairs be altered? How can the type of lad who thinks for himself, takes a real interest in his work, and who has initiative, but who under the present system is not given a chance, be encouraged? Individual firms should organise some annual system of competitive tests and examinations of appreciably high standard. Encouragement and personal interest should be taken in the successful candidates, and chances of promotion and special training based on the results of these tests. Not only would this attract a better type of apprentice-moulder, but it would repay the concern who adopted the system.

It is as vital for the foundry industry to be well equipped with a plentiful supply of really expert workers as in the case of any other industry.—Yours, etc.,

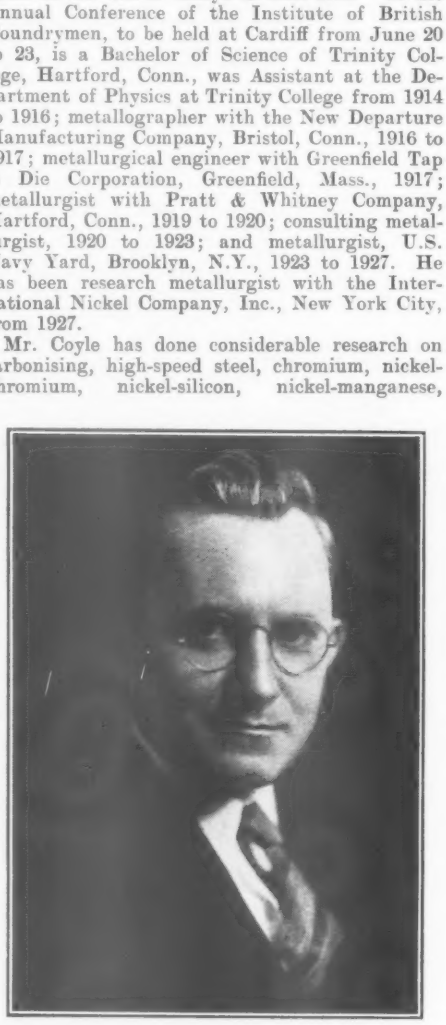
H. Todd.

Risley Lodge,
Near Derby.
April 25, 1933.

To Present American Exchange Paper.

Mr. Francis Brien Coyle, who is to present the American Exchange Paper on "American Progress in the Use of Alloys in Cast Iron" at the Annual Conference of the Institute of British Foundrymen, to be held at Cardiff from June 20 to 23, is a Bachelor of Science of Trinity College, Hartford, Conn., was Assistant at the Department of Physics at Trinity College from 1914 to 1916; metallographer with the New Departure Manufacturing Company, Bristol, Conn., 1916 to 1917; metallurgical engineer with Greenfield Tap & Die Corporation, Greenfield, Mass., 1917; metallurgist with Pratt & Whitney Company, Hartford, Conn., 1919 to 1920; consulting metallurgist, 1920 to 1923; and metallurgist, U.S. Navy Yard, Brooklyn, N.Y., 1923 to 1927. He has been research metallurgist with the International Nickel Company, Inc., New York City, from 1927.

Mr. Coyle has done considerable research on carbonising, high-speed steel, chromium, nickel-chromium, nickel-silicon, nickel-manganese,



Mr. Francis Brien Coyle.

chromium-molybdenum steels, plain and alloy cast iron, heat-treatment of cast iron, white iron and chilled rolls, and he has developed and patented a process for producing cast iron with the strength of cast steel (Ni-Tensyliron). Amongst his principal publications are the following:—"Notes on Quenching Stresses and Failures" (American Drop Forger, March, 1920); "Properties and Heat-Treatment of Cast Iron for Diesel Engines" (A.S.S.T., September, 1927); "Study of a 36-in. Cupola" (A.F.A., 1929); "High-Strength Cast Iron" (A.F.A., 1929); "Nickel and Chromium Extend the Field of Application of Cast Iron" (Metals and Alloys, December, 1929); "Static Strength of Plain and Alloy Cast Iron" (A.S.T.M., 1929); "Heat-Treatment of Cast Iron" (A.S.T.M., 1929); "Calculation of Cupola Charges" (International Nickel Company, Inc., December, 1930); "High-Test Alloy Cast Iron" (Western Metal Congress, February, 1931); "Alloy and High-Strength Cast Iron in U.S.A." (First Communication, Int. Assoc. for Testing Materials, Zurich, 1931); "Heat-Treatment Fundamentals of Plain and Alloy Cast Iron" (Metals and Alloys, September, 1931). He has also presented a number of unpublished discourses before local technical groups and universities in the United States and Canada.

Random Shots.

For one week only "Marksman" is making a remarkable offer. At enormous cost he has produced the first complete glossary of foundry terms ever published in the English language. It has entailed the services of a large number of experts over several months. It is printed in fine, clear Dingdong type, on good-quality Indian paper, and is bound most sumptuously in crushed leather. To secure a copy of this valuable work follow out these simple instructions. (1) Collect twelve final demand notes. (2) Send these to "Marksman" accompanied by a postal order for one guinea (which sum just covers cost of production and postage). (3) The glossary, packed in a presentation cardboard box, will then be mailed to you C.O.D.

* * *

The following specimen definitions indicate the extreme care taken to ensure accuracy.

Blast.—Air blown into the cupola. Balance it if you can. If you can't, avoid excess—the foreman can then supply the deficiency.

Coke.—Combustible material, occasionally assumed to be comestible.

Daylight.—Illuminant. As such adopted only in recent years by foundrymen.

Elevator.—"Up lift" in the foundry.

Flask.—Foundry essential. Snap type has now superseded the hip-pocket variety.

Graphite.—Scientist in the foundry.

* * *

Head.—Runners are sometimes beaten by one of these.

Ironworks.—Building generally constructed of brick, cement, etc.

Jolter.—Machine that never fails. Even when broken down it can give a nasty jolt.

Knock-out.—Castings are never in fine fettle at this stage.

Loam.—Mould.

Mould.—Loam.

Nitriding.—What the foundry salesman has to do at times.

Overheads.—The Economic Sword of Damocles.

Pick-up.—Hole in the foundry floor.

Quenching.—Popular foundry process. Reduction in cost has recently been achieved.

* * *

Refractory.—Any material used in the foundry.

Scale.—A weighty topic amongst metallurgists.

Tap.—Work that develops a thirst.

Unsoundness.—The state the foundry is in when closed down.

Welding.—A process which no steelfounder has ever occasion to use—his castings being always perfect.

* * *

A manufacturer advertised for an office boy, and amongst the applicants was a bright-faced little boy.

"What's your name, my little man?" asked the manufacturer.

"Herbert Sutcliffe, sir."

"By Jove! That's a good name. Just you stay behind till I've seen the others. A boy with a name like yours deserves something."

He got rid of various other applicants. The last was a little Jew, who had listened attentively to the conversation.

"What's your name?" he was asked.

"Jack 'Obbs, sir."

"Jack . . . Why, that's extraordinary. How do you spell it?"

"J-a-c-o-b-s, sir."

* * *

One of a party of card players returning from the races threw down his cards in disgust.

"I'm finished," he growled. "The game's not straight."

"Wot yer mean," demanded an indignant player, "sayin' it's not straight?"

"Becos," snorted the first man, "you ain't playin' the 'and I dealt yer."

Marksman.

International Foundry Trades' Exhibition.

THE INAUGURAL LUNCHEON.

Many exhibitors and visitors attended the inaugural luncheon of the Foundry Trades' Exhibition at the Agricultural Hall on Monday, April 24, over which Mr. D. H. Wood, the President of the Foundry Trades' Equipment and Supplies Association, presided. The company included Sir William Larke, K.B.E. (Director, Federation of Iron and Steel Manufacturers), Mr. A. L. Hetherington, Mr. J. H. Holroyd, Mr. A. S. Beech, Mr. J. G. Pearce (Director, British Cast Iron Research Association), Mr. Wesley Lambert, C.B.E., and Mr. V. C. Faulkner (Past-Presidents of the Institute of British Foundrymen), Mr. W. R. Long, Mr. J. Buchan, Mr. G. Zimmermann, Mr. A. W. G. Bagshawe, Mr. E. Lowes, Mr. H. Winterton, Mr. F. Bertram, Mr. J. W. Gardom (Convener, Technical Committee, Institute of British Foundrymen) and Mr. T. Makemson (Secretary of the Institute of British Foundrymen).

Sir William Larke, proposing success to the Exhibition, said that his inspection of it so far had been all too short, but, in his opinion, it achieved a standard at least as high as, if not higher than, that of its predecessors, not necessarily in numbers, but in the achievement and progress which it measured. It reflected the greatest credit upon the industries represented, and it was high praise to say that it at least reached, if it did not excel, the high standard they had learned to expect from Messrs. Bridges, the organisers.

Technological Position of British Industry.

It also carried a very important message. There were people, having little connection with industry, who frequently suggested that if only industry knew its business better industry would benefit. That was at least a recognition of the truth that industry, in this the most highly industrialised country in the world, was the basis of our national life and our national economy. But the suggestion that industry was technologically inefficient was, at least as regards the foundry industries, effectively refuted by this exhibition, and it was also refuted, by those who had any knowledge of it, throughout the whole realm of British industry. He had had exceptional opportunities during his life of becoming acquainted with technological achievements in British industry, not only in engineering, but throughout practically the whole range of manufacturing industry, and as a result he could say without hesitation that technologically British industry was unsurpassed by that of any other country in the world. In support of that he would ask the somewhat hasty critics to reflect upon the triumph of British industry during the war years; never did any other industrial country approach the effort and achievements of British industry during that period. That was not to detract from the great effort which Germany had made during the war, but in adaptability to circumstances, in originality, enterprise and energy, British industry during that period was unsurpassed—as he believed it to be to-day.

Meeting Post-War Conditions.

But there was one aspect of British industry in respect of which we had to change our ideas and our methods. In a world of expanding markets, individual competition was certainly a stimulus to progress, but in post-war conditions, for reasons outside the control of industry itself, markets were perhaps contracting to some extent (though potentially those markets were capable of expanding to the same degree as, if not to a greater degree than, was experienced before the war), and industry must approach its post-war problems, not from the individual competition point of view, but from the co-operative point of view. It was essential that all engaged in industries of a like kind should co-operate to prevent unrestricted, uneconomic competition, which only resulted in the distribution of liquid assets with the product. Let us clearly understand that no one individual industry or country could become prosperous at the expense of the bankruptcy of another; any bankruptcy, wherever it occurred, whether it be that of an individual, an industry or a country, obviously decreased the consuming power of the community or of the world.

Our object in industry, therefore, must be to establish such a degree of co-operation that we had a conscious policy for strengthening our competitive power in the world markets. This meant that the whole vertical combination of industry, from the primary materials obtained from mother earth to the finished products which formed the basis of our export trade, must be so arranged that each section made a reasonable profit on its operations. Without that it was impossible to contemplate the restoration of a condition of expanding markets and, what was even more important, employment for the people in this and other countries. Having organised ourselves on a national basis with that ideal, we

Sir William Larke, K.B.E.

should then endeavour to co-operate with other countries, so that we might organise the trade of the world on the basis of pooling our resources for the stimulation of that enormous world demand which potentially existed, but which was restricted only by reason of the fact that purchasing power for the moment was reduced, owing to conditions that were, generally speaking, entirely outside the control of industry.

Co-operation for Efficiency.

Let the industrialists concentrate on the problems within their own control, *i.e.*, the more efficient organisation of the industries, particularly those that were interdependent in the economic sense. Technologically we were making progress as rapidly as could reasonably be expected; with regard to the distribution of our products, we had to change our views entirely from those we had held in pre-war years, under the different conditions then existing. So confident was he of our ability to do so that he looked forward to advancement in the future. He hoped the advances made would be slow and sure, and he appealed to leaders of industry to ensure that, as the expansion of markets occurred, and as we reached a condition which some people would like to describe as a boom, they would resist the temptation to allow a price boom to occur again, and would use the whole of their influence and exertions to make that boom, which must come in time, a volume boom, so that it produced the maximum volume of employment, and would enable price levels to be reduced, not because of senseless competition, without thought or relevance to costs, but because our technological efficiency had increased.

Such sentiments as these needed expression from time to time. Indeed, Sir William would like to see a new crusade in this country, preaching the prosperity of industry. He had every confidence in the future; we in this country had no need to be down-hearted or even to resent the criticism to which he had referred earlier, because not only was that criticism unjustified, but we knew also that our industrial structure and industrial leaders were competent and willing to lead the country back to an era of industrial prosperity and increased employment as soon as conditions permitted—and, indeed, we were at present engaged in an effort to create the conditions on which that return to prosperity depended.

Sir William commended to the gathering the success of the exhibition, which bore such striking testimony to the technological progress, achievement and enterprise of this country; he wished success not only to the exhibition but also to the whole foundry industry, whose efforts, he was confident, would be rewarded by increasing prosperity in the immediate future. Finally, he coupled with the toast the name of the chairman.

Well-Equipped Foundries Busy.

Mr. D. H. Wood (President of the Equipment Association), after thanking Sir William Larke for having spared time to attend the luncheon and to propose the toast, ventured to say that no foundry exhibition organised in this country or elsewhere had produced exhibits of such high quality, of such good workmanship, design or construction as had this one. The Association looked upon the exhibition with feelings of profound optimism. It believed that the exhibition was being held at a time of definite improvement in business. The foundry trade had suffered very considerably from depression during the last three or four years, and the exhibition, though planned two years ago, was being held just at the right time. The days when anything was regarded as good enough for the foundry had passed, he hoped beyond recall, and foundry directors and engineers were realising that their equipment and methods must be modern. That was another reason why the exhibition was opportune.

It was said that the engineering industry as a whole was badly off for orders, but he questioned the truth of that, and ventured to suggest that, if figures showing the output of foundries during March, for instance, were available, it would be found that those foundries which were well equipped and well organised were producing practically to the limit of their capacity. There seemed a moral in that statement, if it were true, so obvious that it need not be stated—but the Editor of The Foundry Trade Journal had full permission to use it as the text for his next sermon.

The Equipment Association could do but little to help the foundry industry in its fight against fabricated steel, but it had made an innovation, and the technical exhibit included special-duty irons and castings which it was known had replaced drop forgings. For that exhibit thanks were due to the Technical Committee of the Institute of British Foundrymen, and Mr. Wood paid a tribute to the committee and its convener, Mr. J. W. Gardom; the results which Mr. Gardom and his team had produced were excellent, and the Equipment Association was deeply indebted to them.

Mr. A. S. Beech (Past-President of the Association) proposed a toast to "The Visitors," who constituted the majority of the gathering, and he coupled with the toast the name of Mr. Wesley Lambert. He expressed the hope that the order-books would be well filled.

The Technical Exhibit.

Mr. Wesley Lambert (Past-President of the Institute of British Foundrymen), in response, said that notwithstanding the arduous work entailed in the arrangement of the exhibition, the hosts had not fallen short in their hospitality to

their guests. In a tribute to Messrs. Bridges, the organisers, he said that all who knew them were well aware of the efficiency with which they carried out any project to which they applied themselves, and as a typical example of the confidence with which Messrs. Bridges undertook all their projects, he read a telegram he had received from them, which read: "You have been put down to respond for the visitors; very many thanks."

In commending to all present the exhibit of the Technical Committee of the Institute of British Foundrymen, Mr. Lambert said it was much more ambitious even than he had anticipated, and it was surprising that such a fine exhibit could have been produced by a Committee which had been established only about two years. Thanks were indeed due to Mr. Gardom, the Convener of the Committee, and to the Committee and its various sub-committees.

The greatest compliment that the visitors could pay to their hosts was that they should do their very best to make the exhibition the most successful foundry exhibition ever held in the Kingdom. Congratulations were due to the organisers for having the confidence to stage it at such a time as the present, and he was proud that there were such men as Mr. Bridges and his sons to carry on the work.

REFRACTORIES ASSOCIATION LUNCHEON.

On the second day of the Foundry Trades' Exhibition, the Refractories Association of Great Britain were the guests of the organisers. Mr. D. H. Wood, chairman of the Foundry Equipment Association, presided, and the principal guest was Mr. Harry Winterton, president of the Refractories Association of Great Britain. Among the guests were Mr. Harry Coggan, Mr. A. J. Arnold, Mr. F. G. Foster, Mr. Frank S. Russell, Mr. F. J. Boam, Mr. W. J. Rees, Mr. F. E. McGrath, Mr. V. R. Westcott, Mr. F. M. Fisher, Mr. F. J. West, Mr. Wesley Lambert, C.B.E., Mr. V. C. Faulkner and Mr. F. K. Neath.

Progress of the Association.

The toast of "The Refractories Association of Great Britain" was proposed by Mr. H. Coggan, of Messrs. Augusts, Limited, who spoke as an important user of refractory materials. He congratulated the Association on the truly remarkable progress it had made since its inauguration in 1918.

Mr. H. Winterton, in reply, said that by co-ordination of effort the refractories industry had contributed largely to the progress of the metallurgical industries through the harnessing of research to their problems. At no period were the iron, steel and foundry industries in possession of better refractory materials than at the present time, and this he claimed was due in no small measure to the efforts of the Association over which he had the honour to preside.

Mr. F. J. West proposed the toast of "The Foundry Trades Equipment and Supplies Association," coupled with the name of its president, Mr. D. H. Wood, and in reply Mr. Wood said that on the first day the exhibition was visited by foundrymen from Australia, New Zealand, India, Germany, Denmark and Holland. That was certainly an excellent beginning.

B.C.I.R.A. AND N.I.F.E.A LUNCHEON.

A luncheon was held at the Exhibition on Wednesday, April 26, on the occasion of the official visit of the British Cast Iron Research Association. Mr. D. H. Wood (chairman, Foundry Trades Equipment and Supplies Association) presided.

The occasion was quite informal, and the chairman, in offering a welcome to the members of the British Cast Iron Research Association and the National Iron Founding Employers' Association, expressed the hope that the exhibits in the Exhibition would not only be found of interest, but that the sales appeal of the exhibits would prove irresistible. Commenting on the fact that he had been asked why the number of exhibits in the Exhibition were somewhat lower than had been the case at previous Exhibitions, the chairman said the only answer he could give to that question was by asking another question, namely, "How many pessimists are there in the world in comparison with the optimists?" The number of exhibits at the present Exhibition might not be so large, but there was no possible doubt that the quality of them was equal to, if not better than, those at any previous Exhibition. In the same way, although on the opening day the number of visitors to the Exhibition was not so very large, the visitors were in keeping with the exhibits, *i.e.*, they were of the highest possible quality, and the degree of quality was gradually increasing as the Exhibition proceeded. Speaking seriously, the chairman said it was the fact that on the opening day of the Exhibition inquiries were received by exhibitors from visitors representing nine different countries and that augured well for the success of the Exhibition. He could definitely say that the exhibitors had no cause for complaint.

Finally, the chairman said that although there was no definite programme of speeches, there was present Mr. H. J. Yates, Vice-President of the British Cast Iron Research Association, and he would ask him to say a few words.

Technical Exhibition and Scientific Research.

Mr. H. J. Yates, after expressing the thanks of the British Cast Iron Research Association to the Foundry Trades Equipment and Supplies Association, and the Exhibition organisers—Messrs. F. W. Bridges & Sons—for their hospitality, said he welcomed the opportunity of dealing with a few points which might perhaps be emphasised, although they would be dealt with more fully at the meeting of the British Cast Iron Research Association in the afternoon. The Association, he continued, had been intimately connected with every Foundry Exhibition hitherto held in this country, and it had had a technical exhibit on every such occasion. The Association had also been awarded a Gold Medal and Diploma for its exhibit at the recent International Foundry Exhibition in Paris. By arranging an exhibit on such occasions to demonstrate the progress made in the work of the Association, the Council of that organisation was helping to discharge its obligation to the industry as a whole and to maintain the prestige of the industry at home and abroad. Such exhibits, moreover, served a valuable educational function. The Research Association was indebted to some three dozen members for their co-operation in sending illustrations of various developments and thus contributing to the exhibit. This in itself illustrated the co-operative nature of the Association's work.

Additional Support Essential.

The Britisher was characterised as a rule by good sportsmanship, and the industry should recognise that a national body which worked for the benefit of the industry as a whole ought to be supported by the industry as a whole. The Association, therefore, asked for the support of British ironfounders in all branches of the industry, and also in their respective capacities as makers of supplies and equipment, in addition to the support of users. As from June next the Association required to secure an increased income from the industry in order to maintain its grant from the Government, failure to reach which would cause a fall in the grant received and a serious curtailment of the Association's activities. The additional income required was of the order of £1,000 per annum, and this could easily be obtained by the addition of about 40 new members to the Association. The Council did not believe that the industry would allow the work of the Association to be impaired for the want of such a comparatively small sum, particularly as the work of the Research Association enabled economies and improvements in production to be made which far outweighed the annual subscription.

He impressed upon the industry that the Government provided £1 for every £1 in subscription over £3,500 per annum, and it was hoped that by June the subscriptions would be raised to £5,000, but his own view was that if the Association was to continue to do the good work it had set out to do, it would require a minimum income of £10,000 per annum. It was well known, of course, that the Association's laboratories required equipping, and it was open to all concerned with the trade to give something, be it large or small, by way of apparatus. He asked them, however, not to present the apparatus, but to make a subscription to the funds of the Association, naming the apparatus which it was desired should be purchased, leaving it to the Association to purchase the apparatus, because in that way the Association would get the benefit on the £ for £ basis, under the Government scheme for the money so subscribed. Therefore, he hoped those who had not yet supported the Association would do their utmost to assist in every possible way.

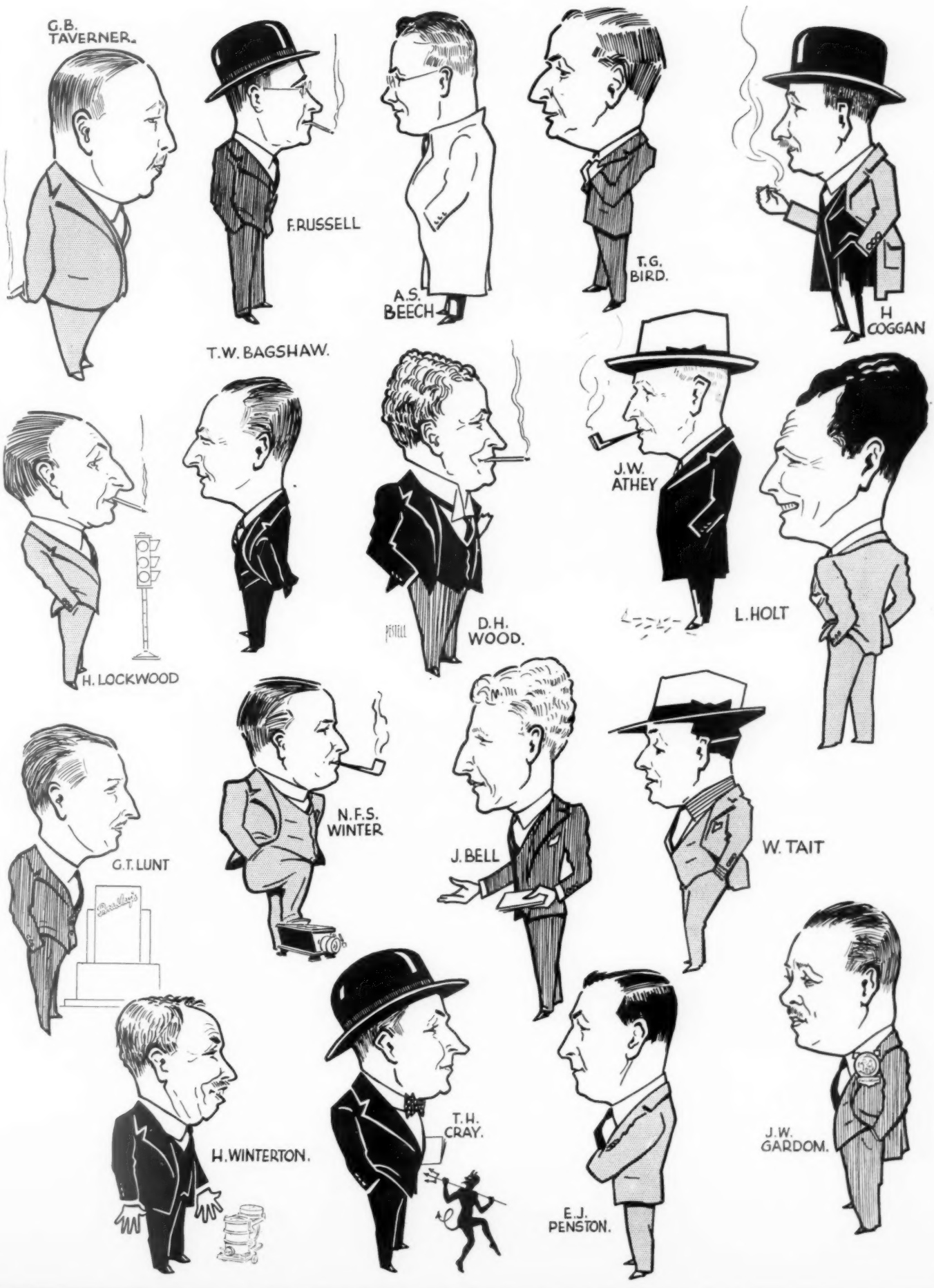
Continuing, Mr. Yates said that, while cast iron is a very complex material and its satisfactory production an intricate process, no industrial field offered such possibilities of sustained scientific research as that of founding, and in none was it more important if the material was to maintain its place in the face of competing materials and methods, and in the face of developments abroad. In engineering, in building, in the arts and in our everyday lives improved castings had a notable contribution to make to modern life. An Exhibition such as the present was a valuable opportunity for learning not only what had been done, but what possibilities of progress lie before us, and careful study of the exhibits, therefore, was to be commended to all those engaged in the industry, old and young, technical and practical.

Discussion on Pig Iron.

Over one hundred members of the British Cast Iron Research Association announced their intention of attending a discussion held at the Foundry Trades Exhibition on April 26. The discussion dealt with the purchase of pig iron, and had been arranged by the Association's Pig Iron Sub-Committee, representing the makers, and the Grey Iron Sub-Committee, representing the users. Mr. H. J. Yates, Chairman of Radiation, Limited, and Vice-President of the Association, took the chair, supported by Mr. H. B. Weeks, Chairman of Council. Mr. P. A. Abernethy, Colvilles, Limited, Glasgow, Chairman of the Pig Iron Sub-Committee, presented a memorandum embodying the point of view of the makers of both pig and refined irons, and Mr. S. H. Russell, S. Russell & Sons, Limited, Leicester, Chairman of the Grey Iron Sub-Committee, presented a memorandum embodying the point of view of the user of pig and refined iron. In order to secure the freest possible expression of opinion, arrangements had been made to treat the discussion as confidential, but the views advanced will be of considerable assistance in promoting a better understanding between the parties concerned and evolving the most satisfactory basis for the buying and selling of pig and refined iron.

Iron and Steel Output in March.

There were 70 furnaces in blast at the end of March, being an increase of 7 since the beginning of the month. The production of pig-iron in March amounted to 332,200 tons, compared with 270,800 tons in February, and 335,600 tons in March, 1932. The daily rate in March was, therefore, about 10 per cent. higher than in February. The production includes 91,600 tons of hematite, 149,000 tons of basic, 78,100 tons of foundry, and 7,800 tons of forge pig-iron. The output of steel ingots and castings in March amounted to 577,700 tons, compared with 482,700 tons in February and 462,800 tons in March, 1932.


G.B. TAVERNER.
F. RUSSELL
A.S. BEECH
T.G. BIRD.
H COGGAN
T.W. BAGSHAW.
J.W. ATHEY
L. HOLT
H. LOCKWOOD
D.H. WOOD.
N.F.S. WINTER
J. BELL
W. TAIT
G.T. LUNT
H. WINTERTON.
T.H. CRAY.
E.J. PENSTON.
J.W. GARDOM.

The Technical Exhibits.

REPRESENTATIVE DISPLAYS AT THE AGRICULTURAL HALL.

Technical Committees' Stand.

The exhibit arranged by the Technical Committee of the Institute of British Foundrymen took full advantage of the occasion to make propaganda for increased membership. The Committee even utilised the subtle arts of advertising by having a mechanical page-boy constantly producing from his bag well-worded slogans designed to "sell membership." Prominent members of the industry were on duty each day to give information as to the advantages offered by the Institute to each individual.

The exhibits were arranged in groups and have been collected by the Sub-Committees on Melting Furnaces, Sands and Refractories, Cast Iron, Malleable, Steel and Non-Ferrous, in co-operation with the British Non-Ferrous Metals Research Association, to illustrate the type of work the Committees are carrying out and the trend of modern foundry practice.

Typical methods of testing used in works practice, recommended methods of producing sound test-bars and castings, with runners and risers left on, and chill positions indicated, were demonstrated. Microscopic equipment was available for the examination of prepared metal specimens and moulding sands.

Charts and typical samples showing the standard method of colouring iron, steel and non-ferrous patterns were prominently displayed, and we were impressed with the interest shown in them. We anticipate that, as a result, the use of standardised-pattern colourings will be much more general.

Melting Furnaces.

The South Kensington Museum provided a series of excellent models of a sectioned cupola, a Morgan oil-fired crucible furnace, an Héroult electric arc furnace and an Ajax Northrup induction furnace, while the Brackelsberg people sent over from Germany a beautiful model of their pulverised-fuel-fired rotary furnaces. The regional coke research committees sent material to show to foundrymen just how the properties of coke are evaluated by means of shatter tests and the like.

Sands.

The need for standardisation was well shown by the various apparatus exhibited for sand testing. Primarily, there was a complete set of the American Foundrymen's Association's standardised instruments, but, so far as the determination of permeability was concerned, there was an interesting modification by Richardson. Then there was a complete set of British Cast Iron Research Association apparatus, supplemented by Buchanan's double-compression method for determining the bond strength of green-sand cores. For the determination of moisture, there were both the Speedy and Richardson's electrical methods.

Our readers will remember the researches of Mr. Ben Hird, wherein he showed that by adding more and more coal dust to sand he could thereby obtain a bond. On the stand actual samples were shown which fully demonstrated the results he had obtained. Exhibits were staged which enabled practical men to correlate "the feel of sand," with its scientifically expressed properties.

Cast Iron.

To the old-fashioned jobbing foundry owner this section was indeed a revelation. Here he had a chance of examining in detail all the new irons to which we have devoted so much space in recent years. They included austenitic, martensitic, various types of high-duty corrosion and heat-resisting cast irons, hardened- and tempered-alloy irons and irons which had been treated by the soda-ash process.

West's recent work on the influence of phosphorus on cast iron was illuminated by his actual samples, and another series demonstrated the effect of casting temperature on shrinkage. Standardised test-bars, both British and foreign, gave the foundrymen a practical demonstration of the trend of thought in the various countries as well as hints as to how they should be run.

Malleable Cast Iron.

It was interesting to note from the exhibit showing how various castings are run, the daily loss sustained by various foundries through the waste of iron used for feeding, if the more lightly fed are still sound, which can, we think, be taken for granted. The work of the committee handling malleable was *inter alia* demonstrated by a zoning chart showing a method of locating any particular area of microsection and by microsections of typical phases in the manufacture of malleable. Examples were shown of Keep's and the spiral "life" tests. The latter was erroneously described as a "fluidity" test. We contributed our small quota by providing an album of illustrations of European mechanised foundries.

Steel Castings.

In this section there were some excellent examples of really thin-sectioned castings. Twenty-five years ago these would have been regarded as the outstanding feature of the exhibition, and in 1913 would have commanded £80 a ton. Now it is the alloyed heat-resisting castings which have to take pride of place. Yet the former still impresses us as the greater achievement.

An interesting composite job was shown in the form of a deck plate with a steel link cast into it. Cast-steel chain is also shown, and buyers of these articles should be made to realise that they should pay a contribution towards the rent of the shop when they place their orders, as chain in its later stages does occupy more than its fair share of elbow-room. Like the other sections, the organisers have shown exactly which is the best method of running test-pieces. Finally, an excellent collection of micro-sections of all types of cast steel was available for inspection.

Non-Ferrous.

The British Non-Ferrous Metals Research Association collaborated with the appropriate sub-committee and showed specimens evolved in the course of their work designed to help the founder to make better castings. One exhibit, for instance, shows the causes and elimination of pinholes in aluminium alloy castings; a rider resulting from this shows that the virgin metal must be stored in a dry place. It also gives hints as to the type of fuel that should be used. Similar samples show the position in regard to gases in copper. The Durville casting process, "life" testing by the spiral method, specific gravity and hydraulic testing were demonstrated by models and test-pieces.

Many of the newer high-duty alloys were shown in the form of castings, and phosphor bronze was represented in the sand-chill and centrifugally cast forms. There were standard test-bars in gun-metal, and we hope our non-ferrous friends derived the maximum benefit from their examination, as it is still causing trouble throughout the country.

The British Cast Iron Research Association Exhibit.

The exhibit of the British Cast Iron Research Association illustrated such developments as lent themselves to this form of treatment on which the Association is working.

Balanced Blast Cupola.

The research work of the Association has shown the great importance to the founder of cupola melting at high temperatures, under conditions of relative freedom from oxidation. These improvements have been realised in the balanced-blast cupola, British and foreign patents for which are held by the Association and the design of which is available to members. Up to the end of March, 1933, thirty-five cupolas of this type had been installed and are in operation, varying in size from 24-in. internal diameter to 64 in., the respective rated outputs of these extreme sizes being 2.3 tons per hr. and 17 tons per hr. No difficulty would be experienced in building these cupolas up to 90-in. internal dia. with an output of about 33 tons per hr. The

The Morgan Crucible Company's Stand had a Comprehensive Exhibit of Crucibles, Furnaces and Refractories.

advantages of their use are hot metal, relatively free from oxidation (as shown by the absence of sparking and ebullition in the ladle) and consequent reduction in scrap and defective castings. Accompanying these advantages is a considerable reduction in the amount of coke, which varies usually from 20 per cent. to 40 per cent. The exhibit included:—(*a*) Drawings of the cupola in various sizes; (*b*) list of cupola manufacturers licensed by the Association to make this cupola and to convert existing furnaces; (*c*) list of patents covering the cupola, held by the Association; (*d*) the advantages of this form of construction; (*e*) photographs of the cupola; and (*f*) illustrations of various types of castings made in the cupola and kindly furnished by various users, including light castings, engineering grey-iron castings, malleable castings (white-heart and black-heart).

The Stand of Stewarts and Lloyds, Limited, showed many Castings made from Their Pig-Iron.

Heat-resisting Cast Irons.

Silal and Nicrosilal heat-resisting cast irons which have been developed by the Association were shown, *e.g.*:—(*a*) Description of these alloys with microphotographs and properties; (*b*) diagrams of the effect of silicon on growth of cast iron; (*c*) micrographs of furnace castings in Silal and grey iron after use; (*d*) micrograph of locomotive firebar before and after use; and (*e*) illustrations of Silal castings and Nicrosilal castings, shown by courtesy of a number of licensees.

High Strength and Alloy Cast Irons.

These were shown by illustrations of plain and alloy cast irons containing nickel, chromium, copper, molybdenum, etc., made in the ordinary way and by inoculation, sand cast or centrifugally cast, for ordinary engineering and special purposes; both pearlitic and austenitic irons are shown. A full-size wood model illustrating a pipe brake made in 1.5 per cent. nickel cast iron—this casting is used in one type of train brake equipment, and from it the whole of the brakes in a complete train are controlled.

Publications.

Examples were shown of publications circulated by the Association. Confidential research reports circulated to members (over 100 issued to date), information bureau reports embodying Papers given by the staff to metallurgical societies or otherwise of importance to the industry (nearly 100 issued to date), and the Bulletin. A special publication on recommended methods of sampling and analysis of cast ferrous metals and alloys is available at 10s. 6d. net.

Malleable Cast Iron.—Cases were on exhibit showing the production and micro-structure and mechanical properties of black-heart and white-heart malleable cast iron with illustrative castings made by the two processes.

Mechanical Testing. — Tensometer testing apparatus, an entirely British-designed and British-made machine for taking transverse, tensile, sheer compression and hardness tests on metals, particularly very small test-pieces, was shown. It is designed for various sizes of test-pieces, from 1/100th sq. in. to 1/7th sq. in. section. For cast metals it is particularly useful for determining the strength of actual castings in thick and thin sections.

Tap Tests.—Two types of spiral test-pieces designed to show the extent to which cast iron is capable of running in a mould are shown.

The Testing of Moulding Sands.

The testing of moulding sands has been intensively studied in late years, and various testing equipments have been designed to give the utmost data on sand for use in the foundry:—(*a*) *A.F.A. Core Box and Core.*—This is a cylindrical core 2 in. in diameter and 2 in. high, and is used for both the A.F.A. compression and permeability tests. The core box is flanged to fit the B.C.I.R.A. permeability apparatus.

(*b*) *A.F.A. Rammer.*—The A.F.A. core is rammed by the dropping of a 14-lb. weight through a distance of 2 in. on to the sand. The sand is rammed by three drops and a tolerance of $\pm \frac{1}{16}$ in. is allowed in the height of the core.

(*c*) *B.C.I.R.A. Strength Core.*—A cylindrical core of 1-in. square cross-sectional area and 2.256 in. high is used for both the strength and permeability tests.

(*d*) *B.C.I.R.A. Strength Core* (Buchanan double compression).—The core box is flanged to fit into the B.C.I.R.A. permeability apparatus.

(*e*) *B.C.I.R.A. Gas Permeability Apparatus.*—The time that gas takes to flow through the cylinder of sand is measured. For comparative results the ramming density, moisture and gas pressure are required to be known.

(*f*) *B.C.I.R.A. Gasometer.*—A floating chamber keeps the pressure constant.

Core Sands, Core Oils and Cupola Refractories.

Subject matter on the following is shown:—(*a*) Core binders; (*b*) green-sand strength of oil-sand core binders (*c*) temperature of failure of artificial binders; (*d*) drying temperature of artificial binders; (*e*) influence of drying temperature on the strength of oil-sand mixtures; (*f*) cupola refractories—samples of cupola bricks and ganister for ramming cupolas are shown; (*g*) a diagrammatic chart of furnace for measuring temperatures in refractoriness tests; and (*h*) briquette test on cupola patching materials—patching material is moulded into briquettes 4 in. by $1\frac{1}{2}$ in. by $\frac{3}{4}$ in., air dried and fired to a temperature of 1,000 deg. C. The contraction or expansion and the general character of the fired briquette is noted. Further series of briquettes are fired at 1,410 deg. C. and 1,610 deg. C.

Gases in Cast Iron.

A panel illustrates a number of experiments on the effect of gases in cast iron in which vitreous enamel has been used to show the presence of gas and the manner in which it leaves the metal. Illustrations of various finishing processes are also shown.

The Stand of Messrs. Tilghman, Limited, displayed a Complete Range of Sand-Blasting Machines.

An order for a coaster of 1,000 tons deadweight has been secured by Messrs. Henry Robb, Limited, Leith. The new vessel, which is to the order of the Coast Lines, Limited, will be motor driven.

F

Institute Visits Exhibition.

COUNCIL ENTERTAINED TO LUNCHEON.

A large number of members of the Institute of British Foundrymen visited the Exhibition on Saturday, April 29, and were entertained to luncheon, at which Mr. D. H. Wood (President of the Foundry Trades' Equipment and Supplies Association, Limited) again presided. The prominent members of the Institute who attended included Mr. Victor Stobie (President), Mr. C. E. Williams, J.P. (President-Elect), Mr. Roy Stubbs (Vice-President), Mr. F. J. Cook, Mr. J. Wesley Lambert, C.B.E., Mr. F. P. Wilson, J.P., Mr. S. H. Russell, Mr. John Cameron, Mr. V. C. Faulkner and Mr. A. Harley (all Past-Presidents), Mr. W. B. Lake, J.P. (hon. treasurer), Prof. Campion, Mr. A. W. G. Bagshawe, Mr. J. G. Pearce (Director, British Cast Iron Research Association), Prof. Andrew, Mr. J. E. Hurst, Mr. J. W. Gardom (Convener of the Institute's Technical Committee) and Mr. T. Makemson, secretary.

The Chairman extended a warm welcome to the visitors, and said there were at least three main reasons why he was glad to do so. The first was that the Institute was the largest and most important body connected with the foundry industry. The second was that their presence was cheering—not that the exhibitors required cheering, for he believed that the whole of the exhibitors were entirely satisfied with the results of the Exhibition so far, and inquiries had been received from 14 countries. The third reason was that the majority of the visitors were potential customers of members of the Equipment Association. Of course, he did not wish to stress that point, but it was one which he would not like them to overlook.

Referring to the technical exhibit, he reminded them that it included castings of special interest, and he hoped that it would appeal to engineers. The Association had done what little it could also in the way of propaganda against fabricated steelwork, which he understood was a more or less serious competitor of the foundry trade. The Technical Committee of the Institute of British Foundrymen had been responsible mostly for the technical exhibit, and was to be heartily and sincerely congratulated upon it. His association with the members of the Institute had been extremely pleasant and happy; he hoped that they would enjoy the Exhibition, that it would come up to their expectations, and, incidentally, that it would possess for them a certain amount of business appeal.

Mr. Victor Stobie (President of the Institute) returned thanks to Mr. Wood and the Equipment Association for their great hospitality. Four years had elapsed since the last exhibition of this kind; enormous progress had been made, both metallurgically and mechanically, and when one considered that progress, one was astounded that there was not more of the wonderful equipment available installed in the foundries. But many of the advances were so recent. On the metallurgical side, for instance, quite a number of alloys, although thought of in the past, had not been put to use until recently. The mechanical advances, particularly in respect of moulding machines, were also of very great interest.

The friendliness existing between the two societies was axiomatic. The welcome accorded members of the Equipment Association to the functions of the Institute was of the type that the Association was extending to the Institute.

It had been stated in a recent issue of The Foundry Trade Journal that practically 80 per cent. of the material exhibited at the Agricultural Hall had not been exhibited previously. Presumably that meant that 80 per cent. of the exhibits were new manufactures, and that was an indication of the wonderful position the industry would be in if it only had the opportunity to give the world the help it was ready to give. He could not remember a period of depression such as the present, and he could not remember a period in which such wonderful progress had been made.

Presentation to Mr. Lambert.

Mr. Stobie then presented to Mr. Wesley Lambert, C.B.E. (Past-President of the Institute), a second Past-President's badge, to replace the original, which had been lost as the result of a burglary at Mr. Lambert's house.

The medal was presented amid applause.

Mr. Lambert, in his response, said he had felt very deeply the loss of his original medal, and although he had replaced it, if it were not presented to him officially he would not feel that it had the same value.

Thanks to Messrs. Bridges.

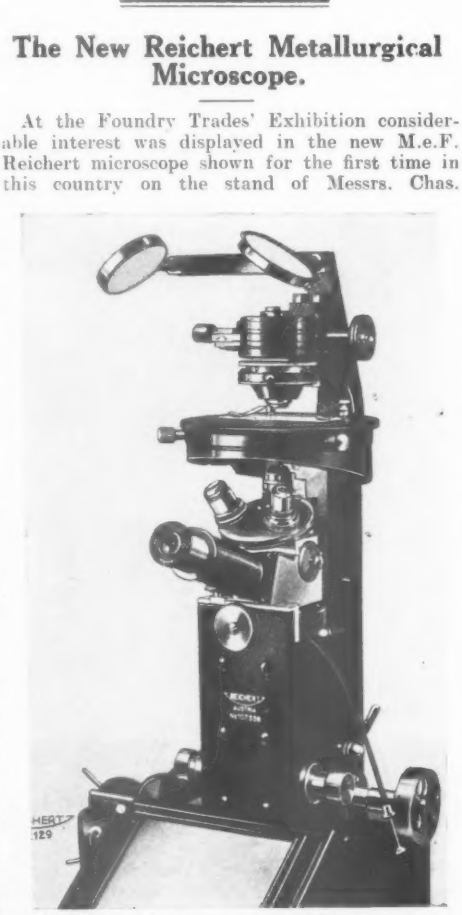
The Chairman informed the visitors that, whereas the invitation had been extended to them in the name of the Equipment Association, it was actually due to the very generous hospitality of Messrs. F. W. Bridges & Sons, the organisers of the Exhibition. He proposed a toast to Messrs. Bridges, and expressed the hope that their generosity and the thoroughness with which they had organised the Exhibition would be well rewarded.

The toast, with which the name of Mr. Kenneth Bridges was coupled, was honoured with enthusiasm.

Mr. Kenneth Bridges briefly expressed his thanks on behalf of his firm and himself, and assured the visitors that their presence afforded him the greatest pleasure.

The New Reichert Metallurgical Microscope.

At the Foundry Trades' Exhibition considerable interest was displayed in the new M.e.F. Reichert microscope shown for the first time in this country on the stand of Messrs. Chas. Hearson & Company, Limited, 68, Willow Walk, Bermondsey, London, S.E.1.



The New M.e.F. Reichert Metallurgical Microscope.

The microscope in general, as seen in the above illustration, is compact, and occupies a bench space of 25 cm. by 35 cm. with total height of 41 cm. It provides for visual observation, photomicrography and, with special attachment, for macrophotography. The lamp house is inbuilt, and the bulb holder is axially movable and can be centred with micrometer screws. The two-lens condenser is fitted with spiral focusing. Five light filters in swing-out mounts permit the use of frosted glass, diffusion screen blue, green or yellow filters. Various illuminations can be used as desired, and with rapid succession, as follow:—Transmitted light: light field, dark field and polarised light. Reflected light: light field with direct or oblique illumination, dark field with concentric oblique illumination by aid of Epilium objectives and polarised light. The interchange of optical detail for these various illuminations can be made with rapidity.

The object stage is either of square or round form. The square having a travel of 50 by 50 mm. by rack and pinion and with verniers to 0.01 mm. The round can be centred with micrometer screws. Coarse adjustment is made by rack and pinion operating the stage. The stage can be locked and the weight of the object is controlled by compensating springs. A scaled index permits the correct setting to working distance of the objectives.

Fine adjustment acts on the eyepiece and by micrometer screw reading on graduated drum to 0.002 mm. objectives are carefully centred on slots and adjusted for tube length of 190 mm. Binocular observation can be made by the insertion of a binocular stereo inset in the illumination tube. Brilliant stereoscopic images are obtained.

The microphotographic detail is well designed. The shutter is situated below the eyepiece section and is adjustable for hand or cable release and permits time, bulb or instantaneous exposures. The reflecting mirror is easily removable for cleaning. The plate size, 9 by 12 cm. with adapters for 6½ by 9 cm. and 4½ by 6 cm., is used. A light protection hood is fixed and plain or ground glass screen can be used as desired.

The eyepieces for visual and photomicrography are correctly adjusted so that visual image is also sharply focused on the screen. The seated observer has accessibility to all working detail, visual or photographic, and the removal of the light-excluding hood and the insertion of plain plate transforms it to a drawing apparatus. The camera length cannot be altered, so that photographs taken with the same objective and eyepiece combination are identical in dimensions. All optical equipment for visual and photomicrography is fitted into a space below the camera screen, and other outfits in cases which act as armrests for the worker. After use, the M.e.F. can be stored, without removal of any parts, in its special cabinet of size 29 by 58 by 46 cm.

Heavy-Oil Locomotives for L.M.S. Railway.

The L.M.S. Railway Company announce that they have decided to make an extensive trial of heavy-oil locomotives for shunting purposes. In addition to the 0-6-0 shunting locomotive, which has been constructed in the company's workshops and which is now undergoing trials, 11 locomotives are being obtained from manufacturers, as follow:—Sir W. G. Armstrong Whitworth & Company, Limited, Newcastle-upon-Tyne, one shunting locomotive, fitted with 250-h.p. heavy-oil engine and Diesel-electric transmission; Hunslet Engine Company, Limited, Leeds, three locomotives, fitted with 150-h.p. heavy-oil engines and mechanical transmission, and one with 180-h.p. engine; Hudswell, Clarke & Company, Limited, Leeds, two locomotives, fitted with 150-h.p. heavy-oil engines and mechanical transmission; Drewry Car Company, Limited, London, one locomotive, 160-h.p. engine, mechanical transmission; Harland & Wolff, Belfast, one locomotive, 170-h.p. engine, mechanical transmission; "Sentinel" Waggon Company, Limited, Shrewsbury, two locomotives, fitted with Sentinel-Doble oil-fired boilers, automatically controlled. The Sentinel-Doble engines are directly geared to each axle.

Some Factors Affecting the Soundness of Bronze Castings.*

By E. J. L. Howard.

Considerable research has been carried out for some years on the soundness of castings, but there is still a diversity of opinion regarding the principle underlying their production. Probably, the prevailing opinion indicates that the unsoundness in bronze castings is due to oxidation and porosity, the latter being due to gas occlusions or shrinkage. Unsoundness or porosity in

FIG. 1.—PUMP IMPELLER, GOOD AND BAD, AFTER SERVICE WITH ACID MINE-WATER.

bronze castings may arise from a number of causes; for example, blow-holes, sand-inclusions, dross, or cold-shut, release of absorbed gases upon solidification, and faulty pattern design which may result in shrinkage holes or cracks. These defects can arise and be influenced during the melting practice by a number of factors, such as casting temperature, impurities in the metal, condition of sand, etc. There is often a tendency to describe cavities simply as blow-holes, porosity or sponginess without clearly indicating their cause, or even to assign an erroneous cause without sufficient reason. For instance, the release of absorbed gases may be sometimes

FIG. 2.— MICROSTRUCTURE OF GOOD IMPELLER. 100 DIAMETERS.

blamed for cavities which can correctly be ascribed to shrinkage. Porosity, resulting in seepage under pressure is often the result of intercrystalline fissures. All castings which have to withstand hydraulic pressure must be free from these defects.

The demands upon the casting become more severe as the pressures are raised, and the removal of the skin by machining imposes a still greater necessity for intrinsic soundness in the material. Unsoundness in bronze castings does arise from many causes, but there are certainly two general causes: porosity which develops due to the evolution of gases during solidification of the bronze and unsoundness due to the shrinkage of the bronze. Frequently the unsoundness in a casting is not discovered until it has been machined and tested, or often, until it has been in service and failure has occurred.

Numerous cases can be quoted of failure under severe conditions of service which are directly due to the presence of oxides, or porosity which has resulted in intercrystalline fissures in the casting, although prior to being put into service the castings appeared to be perfectly sound. For castings which have to withstand these severe conditions of service it is essential that they be free from impurities as well as inclusions and porosity.

An illustration of this (Fig. 1) is shown by the photograph of a pump impeller, and the remains of one. The sound one had been in service a number of years, while the one which failed had only been running a few months. Both were dealing with an acid mine water under exactly the same working conditions. The composition of both was similar, the materials being phosphor bronze of approximately 90 per cent. copper, 9.5 per cent. tin and 0.5 per cent. phosphorus. The microstructure of the good impeller (Fig. 2) showed the metal to be free from oxide inclusions and porosity and to have been cast at a reasonable temperature. That of the failure (Fig. 3) disclosed the presence of porosity and oxide inclusions along the grain boundaries. Also the metal had been cast at an unsuitable temperature. Castings made of metal in this condition are bound to fail when put into service where the conditions are at all severe.

Shrinkage.

Solid metals are invariably denser than the molten metals from which they are set. Thus a given quantity of solid metal occupies less volume than when liquid, and unless an adequate supply of metal can be supplied as the casting sets, sponginess and porous areas will occur, permitting leakage under the hydraulic test.

Shrinkage can be differentiated into three varieties, as follows:—

(*a*) *Liquid Shrinkage.*—Contraction in volume of the liquid metal from the temperature at which it is cast to that at which it is just on the point of solidifying.

(*b*) *Solidification Shrinkage.*—Contraction in volume in passing from the molten state at the freezing point to the solid state at the freezing point. This may, of course, be an expansion which one gets with some of the bismuth base alloys.

(*c*) *Solid Shrinkage.*—Contraction in volume cooling from the solid state at the freezing point to normal temperature. The linear contraction here is the patternmaker's shrinkage.

The critical period during the production of sound castings is the solidification period, that is, the transition from liquid to solid. During freezing, there is an alteration in volume between liquid and solid. In most bronzes, the temperature interval between initial crystallisation and complete solidification is considerable, and it is prolonged in heavier sections. This period, besides allowing reduction of gases, also allows the formation of coarse crystalline structures and the separation of eutectoid, whose contraction characteristics may vary from those of the rest of the metal. Furthermore, during the freezing range, solid and liquid phases are present simultaneously, the inter-mixed crystals and liquid forming a pasty condition which it is obvious is not particularly helpful to the feeding of the casting, and which may prevent the escape of any gas which may be generated. When the outside of a mass of molten bronze reaches the temperature of the commencement of solidification, only a portion of the outside layer solidifies, and the bulk of the layer remains liquid until the temperature has fallen considerably below the temperature of the commence-

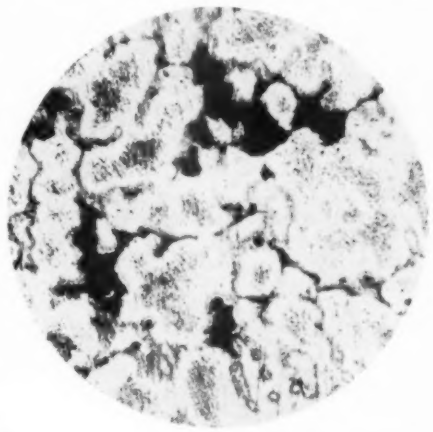


FIG. 3.—MICROSTRUCTURE OF BAD IMPELLER, SHOWING POROSITY AND OXIDE INCLUSIONS. 100 DIAMETERS.

ment of solidification and has started to solidify, and so on, and it can be seen that solid metal has started to form a good way into the casting before the first layer has passed through its pasty stage.

The first stage in the freezing of the outside layer is the formation of a network of solid metal. These are dendrites, and from this network, arms of metal grow into the interior. From these first arms or dendrites, as the temperature falls, smaller dendrites branch off at right angles, first at the base, and then gradu-

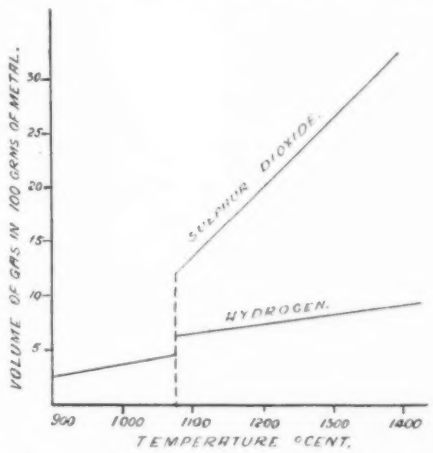


FIG. 4.—EFFECT OF TEMPERATURE ON SOLUBILITY OF GASES.

ally up the length of the shute. From these secondary branches, a third set of branches then grows out again at right angles. With each fall of temperature, the spaces between the branches are being filled in, making dendrites of solid metal gradually thicker at the base, while the tops are continually pushing down into the liquid. During this freezing, bronze contracts considerably. Solid metal occupies less space than the liquid from which it is formed. Thus,

* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. Ellis Flower presiding.

the formation of each branch of solid metal tends to leave space beside it; while any liquid is available, it will fall up to the dendrites and fill the space left by the solidification contraction.

If, for any reason, liquid metal is not available, then voids will be left surrounded by the solid metal. In the resultant castings these voids will be found in the shape of the outline of partly-formed dendrites. Contraction cavities

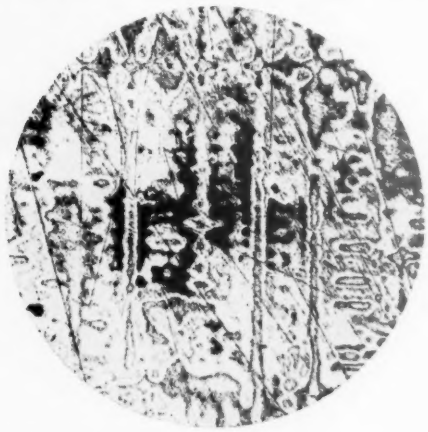


Fig. 5.—Dendritic Form of Porosity in Gun-Metal. 100 Diameters.

will not form if liquid metal is continually available to flow up to the solidifying dendrites, that is, unless gas rejection has already filled these spaces. Even when a supply of liquid metal is available, it has to flow through a maze of dendrites to fill up the spaces. It is advisable, therefore, to shorten its path as much as possible, and be sure that it is adequately fluid, and that there are no mechanical obstructions to impede its flow. The longer the freezing range for a given value of contraction, the more difficult it is to cast the alloy free from porosity. The liquid will have to traverse a thick maze of dendrites to fill up the last cavities.

It is thus desirable that the freezing range should be as narrow as possible. With these conditions it follows that porosity will be most common in sections of improper design. For example, where heavy sections run into light, the long temperature interval between the primary and final crystallisation, the apparently high viscosity of these liquids, and the differences in cooling rates between light and heavy sections of a casting, feeding of the light section at the expense of the adjacent heavy section, will consequently result in foundry shrinkage. When tested, such shrinkages even exhibit the regular direct fracture called oxidation. The most porous sections occur in the centre of the section rather than near the skin. Thus, the factors influencing this type of porosity come into play near the end of the solidification period. This is characteristic of ordinary foundry shrinkage. Also, that is a reason that highly-machined castings are more difficult to make sound than castings which are unmachined. Obviously, chill castings rarely show this type of shrinkage or porosity, the rapid cooling cutting down the time interval and thus minimising the temperature gradients, and allowing less time for selective solidification and segregation.

The Effect of Gases.

Gases undoubtedly play an important part in the soundness of a casting. All metals absorb a certain quantity of gas, and this increases as the temperature rises. Under ordinary conditions of melting there is ample opportunity for metals to come into contact with such gases as oxygen, carbon dioxide, carbon monoxide, and to a limited extent, sulphur dioxide. There is also hydrogen as well as water vapour to be considered. Most of the non-ferrous metals are incapable of dissolving nitrogen, and do not dissolve carbon dioxide directly, although, of course, they may react with the latter, as it is strongly oxidising at the temperature near their melting points. Carbon monoxide is not dissolved in many non-ferrous metals. In fact, it has been found that copper is incapable of dissolving carbon monoxide, nitrogen and carbon dioxide. The amount of gas a metal may take into solution in the liquid or solid condition depends on the temperature and pressure.

All metals in the liquid condition dissolve more gas than they will in the solid state. Also, as the temperature of the metal increases at its melting point the capacity for dissolving gases also increases as is shown in Fig. 4. Due to these changes of solubility at the solidifying temperature, unsoundness or blow-holes may be formed in the casting. If a metal is saturated with gas at the moment of casting, or even if it contains a greater quantity of gas than the solid metal can hold in solution, there must be a tendency for the excess gas to be liberated during the period of solidification, and unsoundness will then be most likely to occur. The amount of gas a liquid or solid metal can hold in solution is proportional to the square root of the pressure, *i.e.*, as the pressure increases, the quantity of gas which can be dissolved in a metal, whether liquid or solid, will increase, that is, assuming the temperature surrounding the metal consists of the particular gas that is under consideration.

The liberation of gas from a metal naturally takes some time, that is, time is necessary for the gases to coalesce in the form of bubbles, and either become indirect as such, or escape from the liquid metal. At an early period of solidification, a crust or envelope around the liquid interior is formed. As soon as this solid crust has become sufficiently thick and strong, any further gas which desires to be liberated from the interior has no means of escape. Consequently, as the change proceeds, there must be a tendency for the internal pressure inside such a casting to increase. As the internal pressure increases so does the solubility of the gas, and in view of this there must be a tendency for the density of the castings to be greater with a diminution in their size. Another factor which is working in the same direction, though to a less degree, is that after the outer shell has been formed the ultimate external dimensions of the casting have been determined, but those outside the shell also begin to contract, and this also exercises a tendency in the direction of increasing pressure.

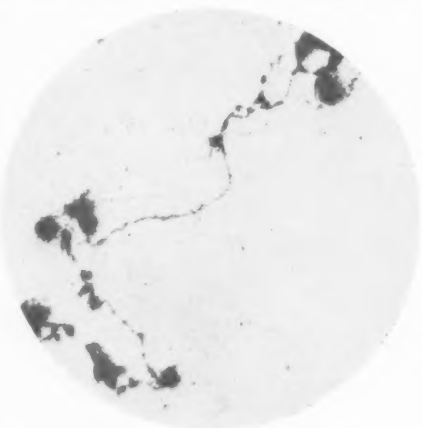


Fig. 6.—Oxide Inclusion Phosphor Bronze, Unetched. 100 Diameters.

The effect of these variable factors is to cause the density and soundness of the casting to decrease with an increase in its size; that is, the larger the casting the more likely is it to be unsound due to dissolved gases. It will be readily understood that the casting temperature, and temperature of the mould, considerably influence the foregoing factors, and the density is affected by them all. The higher the casting temperature the slower the rate of solidification, and the higher the temperature of the mould, the lower will be the rate of solidification.

Hence, with these variables entering in, there is a difference in the facility with which gases are set free, with the formation of gas bubbles or blowholes. This is seen by the fact that sounder castings are invariably obtained by casting in chilled moulds than by casting in sand, which is again due to the fact that gases can be less easily liberated with the quick cooling obtained by casting in chilled moulds, and not because the castings so produced contain less gas. It is by no means easy to produce sound castings capable of withstanding high hydraulic pressure, but there is nothing like the same difficulty if chilled moulds are used. Under these conditions the gas that the liquid metal contains has not full opportunity to become liberated, and so gives rise to porous castings.

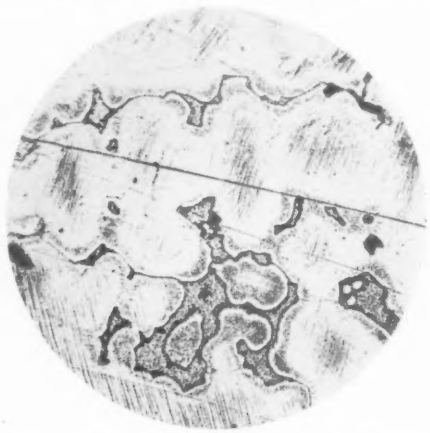


Fig. 7.—Oxide Inclusion Phosphor Bronze, Etched. 100 Diameters.

A large proportion of the copper used at present contains dissolved hydrogen because of the conditions under which it is manufactured. Further, it also contains a certain amount of copper sulphate which, during melting, decomposes, to form sulphur dioxide, which is easily dissolved by the metal when in the molten state. Therefore the gases influencing copper and its alloys consist chiefly of hydrogen, sulphur dioxide and oxygen. The rate of cooling during solidification has a substantial influence upon the facility with which gases are evolved from the metal. Therefore, with extremely slow rates of cooling, the liberated gases would have every opportunity of getting away from the liquid, and also escape from the mass before complete solidification, so that with proper care during re-melting, to prevent the metal again dissolving gases on casting, we should have nothing like the same degree of porosity; that is, much sounder castings should be obtained on the second melting.

Sulphur is present in the raw copper, and during melting it will be taken into solution by the metal. With proper care, the difficulty of picking up sulphur from other sources can be reduced. The behaviour of sulphur dioxide toward the molten copper is in one respect fundamentally the same as water vapour. That is, the sulphur dioxide dissolved in molten metal is almost entirely dissociated into oxide of copper and sulphur. The degree of dissociation changes with the temperature. This change makes a big jump at the solidifying point, in the direction of the sulphur dioxide side of the equation, and as this gas is almost completely insoluble in solid copper it tends to give rise to porosity and blowholes.

Molten metal contains more hydrogen in solution than the corresponding solid can hold at the moment of solidification. Even though the amount of hydrogen present in the liquid may

be less than the solid is capable of dissolving, unsoundness may be produced if the metal contains, in addition, some oxygen. This lack of soundness (Fig. 5) is due to the very low solubility of water vapour in solid copper. Further, sulphur in the presence of oxygen will give rise

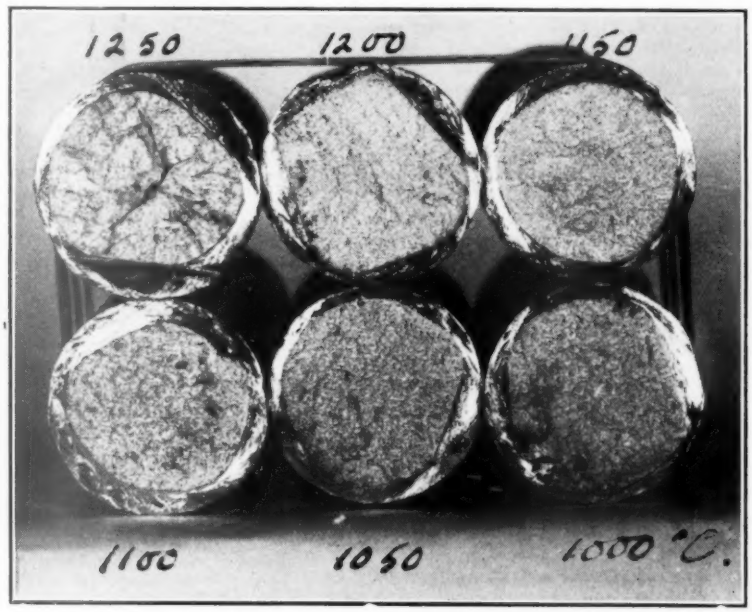


Fig. 8.—Fracture of Bronzes Cast at Varying Temperatures.

to unsoundness as the result of the formation of sulphur dioxide during cooling, especially during the period of solidification.

Oxides.

The oxide of copper which is formed when copper is melted in an oxidising atmosphere is soluble in molten copper, and it is necessary to remove this oxide from the metal. To do this, use is made of some element which will reduce the copper oxide to copper, and release the oxygen to form an oxide of the added element. It is thus necessary that the new oxide which is formed should be easily removed as slag, or it should be sufficiently volatile to burn off. If the new oxide is not readily removable, the last stage will be worse than the first. There are several available de-oxidisers which are suitable for copper. Silicon when added to copper containing oxide of copper reduces the copper oxide to form copper and silicon oxide. The silicon is soluble in copper and is much lighter than the molten metal, so that it rises to the surface of the metal, and is either skimmed or slaked off. Phosphorus readily reduces copper oxide forming an oxide of phosphorus which again is insoluble in the metal and readily rises to the top, either to volatilise or form slag. Manganese, iron and zinc are also suitable de-oxidisers. It is essential that when using a de-oxidiser the oxide of copper is in solution, and a chemical reaction can, therefore, take place. In bronzes a different condition occurs, there being no soluble oxides in the alloy. In the making of bronze, the addition of tin or zinc will reduce the copper oxide forming either zinc or tin oxide, both of which are insoluble in bronze. Zinc oxide is not only insoluble, but is not wetted by the alloy. Also, it is very light and quickly rises to the surface of the metal where it may be skimmed off. It is only when proper precautions are not observed in skimming and pouring that zinc oxide will be found in the castings.

These oxide inclusions are readily apparent without the aid of the microscope, and appear as patches of greenish-white, sandy material, or sometimes looking like a bit of paper which has been screwed up and thrust into the metal. Apart from the unsightliness of such patches of oxide on the machine surfaces of a casting it must be remembered that the oxides are of low mechanical strength, and break up the continuity of the metal and lower its strength. Oxide inclusions also impede the liquid flow during freezing and contraction of the casting, and thus lead to porosity. The elimination of tin oxide is not so easy as it is to free bronze from zinc oxide, because the tin oxide is nearly as heavy as the metal, and therefore, does not readily rise to the surface of the metal, but remains disseminated throughout as insoluble particles. It is essential to prevent oxide finding its way into the casting by mechanical as well as chemical means. The first precaution is to see that the scum from the top of the metal is properly skimmed off. Even then there is an oxide which forms on the stream of the metal as it is being poured into the casting, and to prevent this oxide being carried into the mould, choke runners should be used. Further, there is a danger of oxide forming during the flow of metal about the mould, particularly where large flat surfaces are exposed uppermost.

Aluminium bronzes are probably the type most affected by oxide. Alumina once formed cannot be reduced, and results in lapping of the metal, that is, the oxide gets between the metal and will not allow fusion to take place. The base of all bronzes is copper, and although electrolytic copper is extensively used, probably the majority is of the ingot type which contains a fair amount of oxide. A good guide to the presence of oxide in a bronze is the appearance of the fracture, providing it has been cast under good conditions and at the correct temperature. A fracture which is intergranular and shows specks will undoubtedly contain oxide. Generally, the fractures of bronzes containing oxide are intergranular and show the formation of separate grains. Under the microscope, the appearance shows the presence of hair-like films which usually start from a patch of eutectoid and run to another patch, even bordering along the eutectoid. The presence of oxide of this description is undoubtedly due to faulty melting and mixing practice.

Melting Practice.

If the melting operation is considered as being divided into two parts—(1) that in which the metal is raised from the normal temperature to the temperature of liquification, and (2) that in which the excess heat necessary for handling and pouring is introduced—then the second period is the one in which a reducing atmosphere gives the greatest possibility of gas absorption, because this atmosphere consists of gases formed by incomplete combustion. Since the most harmful effect of gas is due to its precipitation at the temperature of solidification, there is little danger of gas absorption in a reducing atmosphere during this first period. There is, however, in this period a possibility of the formation of sulphides which may subsequently be absorbed by the metal. This quantity, however, would be very low, for fuels which are used for bronze melting should not contain a high-sulphur

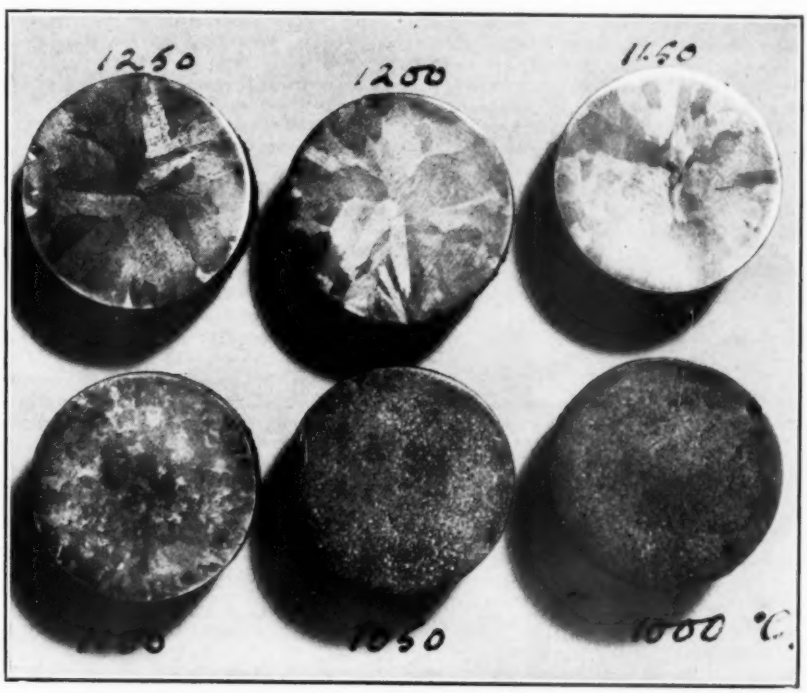


Fig. 9.—Macrostructure of Bronzes Cast at Varying Temperatures.

content, and it would only be by constant remelting of the metal that a high-sulphur absorption would occur.

Though the absorption of gas and the absorption of sulphur are the two most harmful results directly attributable to the melting with a reducing atmosphere, there are indirect results just as harmful which should be considered. When the charge to be melted is made entirely

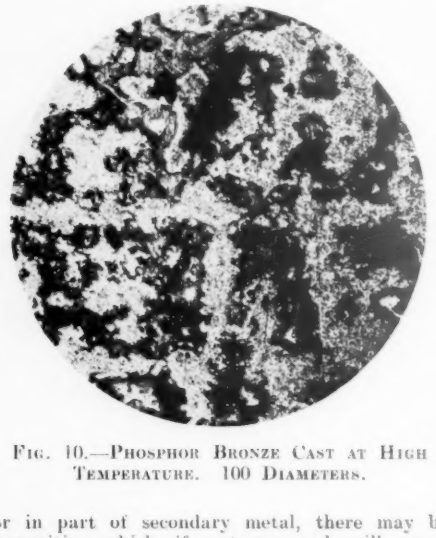


Fig. 10.—Phosphor Bronze Cast at High Temperature. 100 Diameters.

or in part of secondary metal, there may be impurities which if not removed will cause defective castings, such as small amounts of aluminium and silicon. On the other hand, a reducing temperature may be desirable when the metal charge contains metallic oxides. This is particularly true when the oxides are heavier than the resulting alloy. In such a case, reduction may proceed for both periods of melting, and absorption gases may be rendered harmless by their action on submerged oxides. Experiments made by the author have shown that when casting gunmetal at 1,150 deg. C., the density of the alloy was 8.11 when the furnace atmosphere was reducing, 8.75 when it was oxidising and 8.51 when the atmosphere was partially oxidising.

Melting in an oxidising atmosphere may result in serious difficulties due to the formation of oxide in the first period of melting. It is

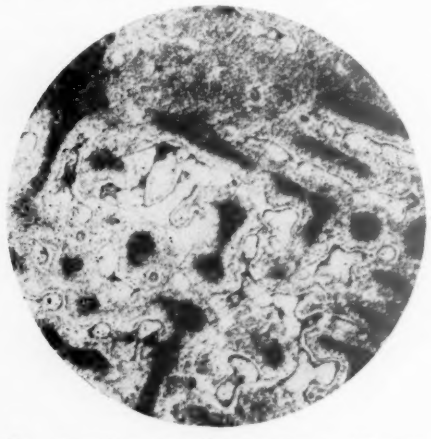


Fig. 11.—Phosphor Bronze Cast at Normal Temperature. 100 Diameters.

then that the metal charge presents the greatest surface to the action of the furnace flame. In most cases, the oxide formed will attack rapidly the lining of the furnace, causing formation of large amounts of slag and contributing to heavy metal loss. In the second period of melting this loss of oxidation is not so heavy, because the slag formed in the first period serves as a protective layer to the melted metal. However, this process of oxidation, if controlled, can be made to serve a definite and useful purpose. The impurities are converted more readily into oxides than are the elements desired. If these impurities are not present in too great a quantity they may be rendered harmless by selective oxidation. Once converted into oxides, such impurities being lighter than the metal bath stay upon the surface and unite with the slag. In addition to this, the excess air of the furnace reduces to a minimum the danger of gas absorption by the melted metal.

It does this in two ways, first by gradually reducing the amount of soluble gas in the furnace, and, secondly, by reducing the solubility of these gases through the presence of oxide in the melted metal. The solubility of hydrogen, carbon monoxide and sulphur dioxide in copper is greatly reduced by alloying with tin or zinc, and is further reduced by the presence of oxygen in the metal, the hydrogen and copper monoxide being oxidised and the metallic oxides reduced. It would then appear that a slight amount of oxide in the metal is of advantage for the production of sound castings from an open-flame furnace where metal to be melted is of the kind here considered. How the correct amount may be kept present is a question for which no hard and fast rules may be laid down. It is a matter of adjustment of practice to suit individual furnace installations and metals to be melted.

The nature of the scrap to be melted must be considered. If it is of poor quality containing oxides and gas inclusions, then it is doubtful if one could produce sound castings whatever the melting practice, type of furnace or temperature of pouring. It is the practice in the foundry with which the author is connected to use only virgin metal to the extent of one-third of the charge, the other two-thirds consisting of equal proportions of runner and risers and ingot scrap. The ingot scrap consists of borings and turnings taken from the machine shop, melted down and ingoted. These are then analysed, and the necessary additions to obtain the desired composition added. Better results are obtained with twice melted metal, and when ingoting the borings it has been found most satisfactory to superheat the metal. All metal at a high temperature absorbs gas and gives it off during solidification. It is far better that this should come off when the metal is cast into ingot form for remelting than it should be found in the ultimate casting. The melting of virgin metal in this manner, ingoting, and then remelting at a lower temperature and as rapidly as possible, for the ultimate casting will be found to give excellent results. It is, of course, essential not to overheat to such an extent that the copper is seriously oxidised and the metal badly stewed.

Casting Temperature.

It is well known that proper pouring temperatures help to minimise porosity, and it is easy to show that castings poured at too low a temperature cannot feed properly, and, as a result, often are unsound, due to shrinkage effect. Furthermore, when poured at too high a temperature there may be actual ejection of the metal with consequent unsoundness beneath. This is probably due to gas rejection as well as external contraction. The effect of pouring temperature are also quite marked on the strength of the resultant alloy as well as affecting the crystallisation characteristics.

The rate of solidification is most important in securing sound castings, and is undoubtedly bound up with the casting temperature and condition of the mould. Variations in the casting temperature affect the rate of solidification for conditions remaining constant, and similarly, variation in the rate of solidification obtained by constant casting temperature in the moulds of different materials also affect the density of the casting in the same way. The casting temperature affects the grain size, hardness and density to a considerable extent, and, if other conditions are equal, the most rapid solidification is obtained at the lowest casting temperature. This, of course, is linked up with the mass of the castings and the surface area. In fact, it is the author's opinion that a large percentage of porous castings can be overcome by the adoption of suitable casting temperatures.

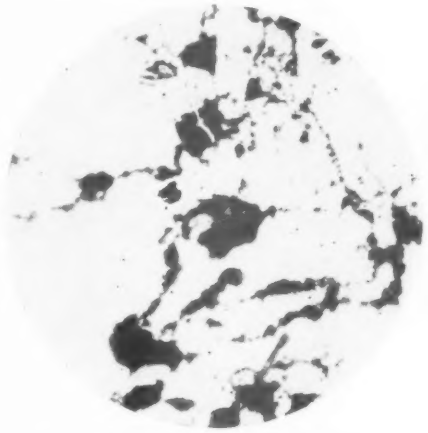


Fig. 12.—Effect of Wet Sand, showing Porosity. 100 Diameters.

Obviously, the casting temperature depends on the section of the casting, and it would be a fault to cast a heavy section at the same temperature as a thin one. With most bronzes there is a fairly wide range which one might term suitable casting temperatures. Above or below these figures will undoubtedly lead to unsoundness, even though all other factors are eliminated. This is shown in Figs. 8 and 9. In the case of Admiralty gun-metal, the range of suitable temperatures extends from 1,100 deg. C. for heavy sections to 1,220 deg. C. for light work. With phosphor bronze there is also a good range. In bronze and gun-metals, the appearance of the runner heads form an indication of the correctness or otherwise of the casting temperature. If cast correctly, they should present a slightly sunken appearance without any bits of tin sweat. The fracture of the metal also is a good indication of the casting temperature

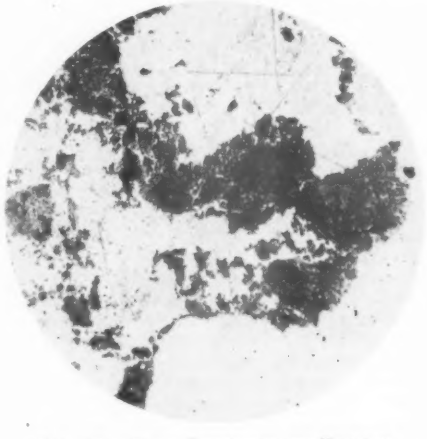


Fig. 13.—Sand Inclusion in Bronze. 100 Diameters.

and melting conditions, but the microstructure (Figs. 9 and 10) and density give the most reliable information.

It has been pointed out by various authorities that even if metal be overheated, providing it is cast at a suitable temperature, porosity due to gas occlusions and shrinkage, does not occur. This was particularly shown by Carpenter and

Elam in a Paper before the Institute of Metals. They stated that Admiralty gun-metal heated to 1,400 deg. C. and allowed to cool down in the pot to a temperature between 1,150 and 1,250 deg. C., gave quite sound castings.

Methods of Running.

The subject of casting temperature is bound up with the method of running, and one should not be discussed without the other. The size of casting runner and thickness of section should be considered before passing an opinion of the casting temperature. Method of running and feeding the casting is of vital importance, and probably the best results in bronze-founding practice are obtained by running the casting as rapidly as possible, consistent with avoiding undue agitation and scabbing of the moulds.

Good raw materials are essential for the production of best-quality castings. Highest-grade engineering and pressure castings cannot be made from miscellaneous scrap, and it is essential to have an accurate store where control of the issue of the various mixings can be obtained. Unless there is some consistency in analysis, which can only be achieved by weighing and close control, it is impossible to maintain a high standard of quality. All virgin metal charges are not essential, neither are they desirable, and excellent castings are made from properly-refined composition ingot.

Effect of Impurities.

In addition to unsoundness, difficulties caused by gases, etc., certain elements included in bronzes as intention or unintentional additions have a considerable effect upon the properties of these alloys. The effect of aluminium is fairly well known. It is readily oxidised and causes oxide films between the grains of the metal. It increases the amount of liquid contraction, and may be responsible for a greater resistance on the part of the alloy to the absorption of the delta constituent if any heat-treatment is carried out. It also has the effect of hardening and embrittling gun-metal. Antimony is also harmful. When present, it reduces the elongation and conductivity of bronzes and increases the brittleness and, further, leads to unsoundness. Antimony is usually found in poorer grades of tin and in improperly-selected composition ingot. Arsenic, bismuth, and iron also affect the soundness and strength of bronzes. Bismuth particularly affects the strength. It separates out as a brittle and intercrystalline constituent. Small amounts of iron do not result in much trouble, but if, however, the quantity increases, it may result in hard spots on the casting due to seggregation.

Unsoundness is often the result of the use of unsuitable sand. It may contain too much moisture and have a low permeability Excessive moisture gives rise to the formation of steam which can react with oxides in the molten metal, resulting in an undue amount of hydrogen which is taken up by the metal when molten, and later released as it cools down. This is shown in Fig. 12. This steam can also become entrapped in the metal just beneath the skin, resulting in small blow-holes. The permeability, of course, affects to a considerable extent the passage of gases through the mould, and it is well worth while periodically carrying out permeability tests. These are best done in the apparatus designed by the British Cast Iron Research Association. This consists of a cylinder which is filled with sand and compressed. It is then connected to a gas supply and the time taken for the gas to pass through the sand is determined. The test is simple and easily applied. Further, it is worth while periodically checking the moisture content of the sand. It is important to remember that the sand should carry the least possible moisture which will give it the maximum strength. Any excess beyond this may weaken the bond, and is simply adding to the amount of steam which must be driven from the surface of the mould when the metal is cast. A typical sand inclusion is shown in Fig. 13.

The unsoundness in bronze castings may be greatly reduced, and in many cases eliminated, by attention to the following factors. The close co-operation between the foundry and designer to provide a casting design which gives as uniform a section as possible. The use of good raw materials where the composition is known; correct and rapid melting practice, if possible in a neutral atmosphere, or, alternatively, slightly oxidising, and the correct pouring temperature for the type of alloy or casting. The last factor, in conjunction with the method of running and rising, is probably the most important.

The Institute of British Foundrymen.

PRESTON SECTION ANNUAL GENERAL MEETING.

The second annual general meeting of the Preston section of the Lancashire Branch of the Institute of British Foundrymen was held in the Technical College, Corporation Street, Preston, on April 5. At the inauguration of this section some eighteen months ago, there was a very willing response to the appeal for foundrymen to come together under the auspices of the Institute, in order to share the fund of common knowledge held among foundrymen of different branches of the industry.

Mr. William Dryden, Jun., the retiring President, in his address, reminded members that though difficulties of trade and consequent difficulties for individuals were many, and appeared to be unsurmountable, it spoke well of the members that they were determined to continue their assembling together in order to make themselves more proficient for any recovery in trade, which was bound to come sooner or later. It was unnecessary for him to point out how difficult it was to obtain orders, but from the technical point of view, in view of the circumstances, it was increasingly more important to ensure by means of mutual help and assistance that wastage and wasters in the foundry were of a minimum production.

He had found that the presidential chair of the Preston section had given to him more pleasure and interest than he had ever anticipated, and whilst he was loath to relinquish the position, he felt that in the President-Elect there was one who would do his best to keep a lively interest among the members, and so develop a spirit of enterprise and co-operation which must lead to an increase in knowledge, and thereby a greater efficiency in the work they had to do.

The meeting unanimously accepted Mr. Dryden's proposal that Mr. Walter West be elected President for the ensuing year. This was supported by Mr. F. W. C. Hinton, of Messrs. Joseph Foster & Sons, Limited, Soho Foundry, Preston, who emphasised the importance of Mr. Dryden's efforts and interest during the past eighteen months, when the teething troubles of this new Section had been cared for by the retiring President. He was quite confident that the Branch would still retain the interest of Mr. Dryden during the coming year, and any assistance that might be required, and which he could give, would be forthcoming from him.

PRESIDENTIAL ADDRESS.

Mr. West then occupied the retiring chair. In returning thanks for his election, the new President assured the members that the high standard that had prevailed in the leadership of the Section up to the present time, he would strive to maintain, and in view of the confidence that they must have in him in view of their unanimous vote, he felt the increased responsibility of exercising every means within his powers to the benefit of members in general.

Mr. R. B. Duckworth proposed Mr. Dewhurst, of Messrs. Dewhurst's Foundry, Preston, to fill the position of Senior Vice-President. In doing so, he reminded members that in Mr. Dewhurst they had a worthy son of an illustrious father, whose history in foundry work dated back for many years in Preston district, and he was quite sure that not only in the position of Vice-President, but also in the coming year when he would necessarily occupy the President's position, the Section had one in whom they could have implicit trust for guidance and welfare. This proposal was seconded by Mr. Green.

The election for the Junior Vice-President's position took place by ballot, and Mr. Hinton was duly elected.

For three positions on the Council of the Section, Mr. H. Theobald, Mr. S. Billcliffe and Mr J. Yates were appointed.

Secretary's Report.

The honorary secretary, Mr. P. Leyland, then presented his report for the session 1932-33, of which the following is an abstract.

The total membership for the year ending 1932 was 72 and 5 subscribing firms, and of these 64 became members of the Institute of British Foundrymen as a result of a section being formed in Preston, the remainder being already members of the Lancashire Branch. The fact that the section belongs to the parent branch in Manchester was claimed to have placed the Lancashire Branch in the proud position of having more members and submitting the largest amount of subscriptions to the Institute of British Foundrymen with the least percentage of those unpaid of any Branch—a point which is much appreciated by the Council in Manchester.

The Papers presented by various authors dealt with aluminium and die casting, brass, coke, foundry costs and general foundry work, and these subjects cover the most important items connected with the foundry industry. Those who participated in the visit to the Altham Collieries in March, 1932, were amply rewarded in seeing the up-to-date plant and the methods employed in their production of coke and by-products. The second annual social, held in December last, was well supported and again proved to be a successful event.

One feature, which is very pleasing, is that Mr. West has again distinguished himself in the foundry industry by being awarded a Diploma for his Paper on "Low Total Carbon Cast Irons and their Service to the Foundry Industry," delivered before the Lancashire Branch in October, 1931.

Thanks were expressed to the Technical College authorities and Mr. Naylor for the excellent facilities afforded for meetings.

The remainder of the evening was occupied by a talk on "The Elimination of Porosity in Cast-Iron Castings to Withstand Pressure." The substance of this talk given by the President, Mr. Walter West, has already been given in Manchester and published in The Foundry Trade Journal of February 2 and 9.

No less than 64 members were present and the practical character of the subject and the talk was amply confirmed by the lively discussion that followed.

New Metal Primer.—A paint, which, when mixed with any normal oil-paint vehicle, is said to produce a metal primer that affords exceptional protection against atmospheric conditions and mild solutions of acids, alkalies and brines, has been developed by the Eastern Mabelite Corporation, 225, Mercer Street, New York. This pigment is produced by using mabelite ore, which contains a suitable conglomerate of ferric oxide, silica and aluminium, and putting it through a new grinding process that more finely regulates the pigment particle size. The coating, which combines an iron oxide sand-coat finish, is claimed to be resistant to mechanical injury. Successful application, it is said, has been made to metal pipe lines, tanks and concrete.—"The Iron Age."

XUM

Birmingham and West Midlands Foundrymen Elect New Officers.

RELATIONSHIP WITH THE CO-ORDINATION COMMITTEE.

Taking the chair at the opening of the annual meeting of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen at Birmingham Chamber of Commerce on April 7, Mr. J. G. Pearce (retiring President) welcomed Mr. F. W. Finch, the original Secretary of the Foundrymen's Association and one of its founders, who in after years became Institute Treasurer. Mr. Finch, he mentioned, was 87 next birthday, which state of longevity suggested that foundry work must be a very salubrious occupation. Mr. Finch resides at Stroud, Glos.

The Co-ordinated Society Meeting.

Mr. Pearce then reported on the position in connection with the Co-ordinating Committee, and said that no resolution would be proposed for reasons which he would explain. The Council had considered the matter very carefully, and had decided to take no action. The Secretary and himself had attended the meetings of the Co-ordinating Committee to discuss the proposals, which were that the Branch should join the three metallurgical societies in the Midlands which operated under the title of the Co-ordinating Committee, viz., the Institute of Metals, the Birmingham Metallurgical Society, and the South Staffordshire Iron and Steel Institute. These three bodies had worked amicably together for some years, and also very successfully, on one common programme of lectures. During the year they each had their own dinners, annual meetings and presidential addresses, but apart from these gatherings the programme was common to all, and each society nominated three or four lecturers during the session. The whole of the members of the three societies were entitled to attend these lectures, and it had been found by experience that this co-ordination of effort had not interfered in any way with the respective memberships.

Their Branch had been invited to join these three societies, and they had responded to the extent of arranging an interchange of programmes and reciprocal invitations to attend one another's meetings. In addition they had endeavoured to avoid any clashing of dates so far as their respective programmes were concerned, but they considered it wiser for the Branch not to go further with these proposals, for three reasons. In the first place the Institute of British Foundrymen was not wholly a metallurgical body. They felt that while certain metallurgical lectures might be arranged with the other societies for a common programme, the Branch would naturally require to hold a number of other lectures or meetings in order to meet the special needs of their members. In this respect they would have been differently placed from the other societies, which could satisfactorily work on a joint programme. The second point was one of finance. The contribution which the Branch would have to make to the general fund, together with the cost of posting to members circulars relating to the joint meetings, would have very nearly doubled their normal expenditure for meetings and lectures. Thirdly, it was found that those members who would be most likely to take advantage of the opportunity to attend the other meetings were already in a position to do so by virture of their membership of one or more of those three societies. The Council, moreover, felt that the Branch could not at present contemplate the additional expenditure required. However, they were anxious to work in the most friendly way with these other societies, to avoid any clash in dates and to interchange invitations to meetings.

James Watt Memorial Scheme.

In another direction it might also be possible to work together a little closer; this was, if both groups decided to participate in the proposed James Watt Memorial Scheme for securing a central meeting place for the whole of the technical societies in the Midland Counties. They appreciated the invitation of the three societies, and felt very sympathetic towards the whole proposal, and it was with a certain measure of regret that they could not proceed further. For they realised that the scheme would have had two important advantages. It would have brought foundrymen into touch with a wider range of metallurgical problems than they were accustomed to in the ordinary way, such as refractories, temperature measuring, alloys and alloy systems and so on. Then, on the other hand, it would have brought other metallurgists and other engineers into closer touch with foundry problems, which would have been all to the good for both sides.

Annual Report.

In his secretarial report, Mr. L. W. Bolton said there had been an average attendance of 38 at the eight general meetings held, while the average attendance at the three works visited was 36. The membership now stood at 232, an increase of six; 18 new members had been elected. Subscriptions totalled £300 6s., and the economical running of the Branch had reduced the estimated expenditure by £10 16s. 8d. Mr. F. J. Hemming, a Branch representative on the Technical Council, had been elected Convenor of the Sub-Committee on Steel Castings. Mr. J. G. Pearce, their other representative, was a member of the Sub-Committee on Melting Furnaces, while Mr. Cooper and the hon. secretary of the Branch had been co-opted on to the Steel and Grey Iron Sub-Committee respectively. The report and accounts were passed.

Mr. Pearce then said it was his privilege and pleasure to propose that Mr. E. J. Lewis (Messrs. Vowles Bros., Limited, West Bromwich), their senior Vice-President, be elected President of the Branch, saying they all knew how alive he was to anything that could be for its advantage. Mr. H. J. Roe seconded, and the election was unanimous.

Presidential Address.

Mr. Lewis said he did not claim to be a technical man, and hoped to see that more lectures on practical matters would be included in their programme. He urged that they should try to induce more skilled operatives to join the Institute, as this was the class of men which their organisation should, and was intended to, encourage, and practical lectures would, he thought, prompt them to come in. He feared that highly-technical lectures made many journeymen feel a little lost.

The new President (having taken the chair) proposed that Mr. G. T. Lunt (Wolverhampton) be the senior Vice-President. Mr. F. J. Cook, in seconding, said in Mr. Lunt they had a commercial man who would help to guide them in that direction. Commending Mr. G. M. Callaghan as junior Vice-President, Mr. Lewis said his whole heart was in the Institute. Mr. Lunt proposed his election. Mr. Pearce proposed Mr. L. W. Bolton to continue as secretary, saying that he put in a great deal of time, was willing and obliging, and deserved every encouragement. All three propositions were carried unanimously.

Mr. E. S. Morgan and Mr. M. H. Curnow were re-elected to the Council, and vacancies were filled by Mr. W. J. Molineux, Mr. G. W. Brown and Mr. E. M. Currie (Coventry). As representatives to the General Council, Mr. H. J. Roe, Mr. W. J. Flavell (West Bromwich), Mr. J. B. Johnson (Tipton) and Mr. G. T. Lunt were elected, the President becoming a member *ex-officio*. Mr. F. J. Hemming and Mr. J. G. Pearce were re-elected to the Technical Council, Mr. Cook observing, amid general agreement, that they were a very good choice.

Institute of British Foundrymen.

WEST YORKSHIRE BRANCH ELECTS NEW OFFICERS.

The annual general meeting of the West Yorkshire Branch of the Institute of British Foundrymen took place on April 22, at the Technical College, Bradford, under the retiring presidency of Mr. A. S. Worcester (Huddersfield). Prior to the meeting the members were the guests of Mr. Worcester for tea.

The annual report, submitted by Mr. S. W. Wise (hon. secretary), suggested there was every reason to be gratified by the steady progress being made by the Branch in numerical strength and in useful service. The membership had been well maintained, and the potential revenue of the Branch slightly increased, while the enthusiasm of members, as indicated by excellent attendances at meetings, was unabated. The whole of the programme of lectures, Papers, discussions and works visits, as arranged by the Council, had been carried through, and discussions had brought out some very interesting points. The discussion on castings *versus* fabricated parts, which had been so warmly debated by the members, had created some special interest outside the district, as well as a measure of criticism from the technical Press, who felt that the discussion—friendly as it actually was—had bordered perhaps rather closely on the lines of a debate between two sides. Another feature of the session had been an instructive lecture by Mr. F. Rowe on non-ferrous practice, and Mr. W. Fearnside's Paper on some general foundry problems had called for some outside comment. The works visit to Messrs. Prince, Smith & Stells, of Keighley, proved extremely interesting and members were impressed by the efficiency with which operations there were conducted. The hope expressed the previous year that one of the Papers given to the Branch might earn the Diploma of the Institute had been realised, Dr. H. W. Swift being the happy recipient.

The Branch, said Mr. Wise, had been placed under a further debt of gratitude to the authorities of the Bradford Technical College for the use of their buildings for meetings, the housing of the library and for assistance in various other ways. It was gratifying to note that during the session the Huddersfield Association of Engineers had invited one of the Branch officers (Mr. R. D. Welford, of Bradford) to give a lecture of interest to founders and those engaged in branches of engineering which came into contact with foundry work. It was desirable that proprietors and principals of foundry firms took a more active interest in their work in the future than they had done hitherto.

The report was adopted on the motion of the President, who paid special tribute to the work and influence of Mr. Wise in his secretarial capacity, seconded by Mr. G. Hall (Shipley) and supported by Mr. J. J. Watson.

The following officers were elected for 1933-34: *President*, Mr. R. D. Welford (Yorkshire Repetition Castings Company, Bradford); *Senior Vice-President*, Mr. A. Walker (Huddersfield); *Junior Vice-President*, Mr. F. K. Neath, B.Sc. (Keighley); *Hon. Secretary and Treasurer*, Mr. S. W. Wise (Bradford). *Council:* Mr. G. Hall (Shipley)—former member of London Branch Council—Mr. S. Carter (Huddersfield), Mr. W. Fearnside (Keighley), Mr. F. Wise (Bradford) and Mr. H. Battye (Sheffield). *Librarian and Registrars*, Mr. G. E. Booth (Bradford) and Mr. H. Holdsworth (Bradford); *Auditors*, Mr. W. G. Thornton (Bradford) and Mr. G. Hall (Shipley); *Representatives to General Council of the Institute*, Mr. A. S. Worcester (Huddersfield) and Mr. F. K. Neath (Keighley); *Representatives to Technical Committee of the Institute*, Messrs. Worcester and Neath.

Mr. Neath gave a report on recent activities of the General Council of the Institute and of various sub-committees, which Mr. Worcester supplemented.

XUM

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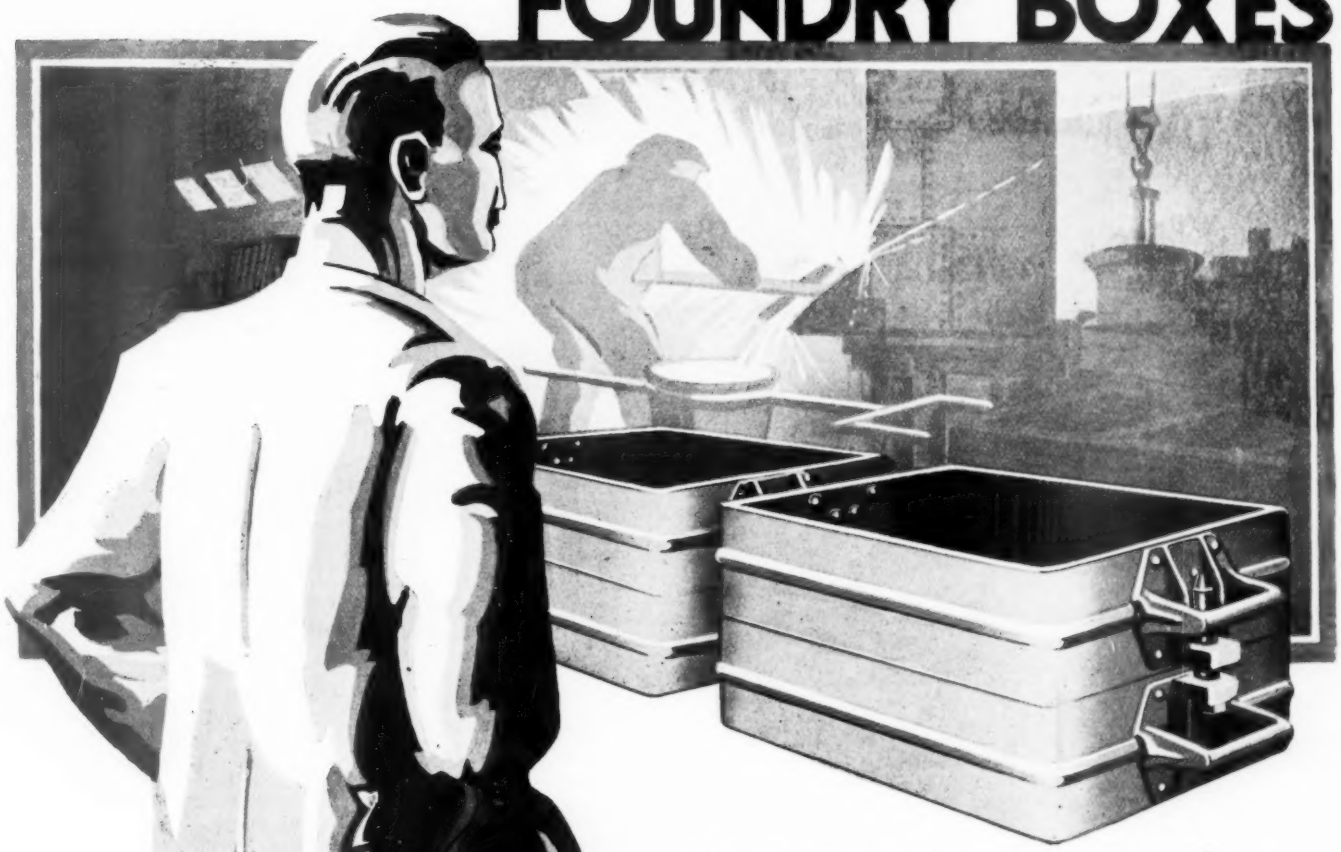

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XUM

Chrome-Nickel Steel Riser Cutting.*

By R. B. Aitchison.

During the last few years there has been a remarkable growth in the development and use of the crome-nickel steels. Steel foundries, particularly those using electric furnaces, are giving more and more attention to the manufacture of chrome-nickel steel castings. In the steel foundry industry it has for many years been standard practice to remove risers by means of oxy-acetylene cutting. When the foundries first began to produce chrome-nickel steel castings, it was found that the customary oxy-acetylene cutting procedure would not work with these oxidation-resistant steels. For a time, then, it was necessary to try other expedients. Nicking and flogging could be used for the smaller risers, but for chrome-nickel risers over 2½ in. in diameter, flogging is fraught with a certain amount of danger, in that there is an equal chance of the break taking out part of the casting proper. Grinding, too, has certain disadvantages: the wheels are quite expensive, last but a short time and are at best only of advantage where the casting, wheel and riser can all be handled easily and efficiently. Obviously, a very heavy casting, or one where the risers are hard to get at, would present handling problems that might often be extremely difficult.

Another method tried during this period of development was the use of an oxy-acetylene

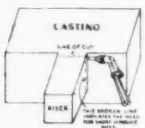

Fig. 1.—Shows Method recommended for Cutting Nickel-Chrome Steel.

welding blowpipe with a large head or tip, the procedure consisting in simply melting out a kerf and blowing the slag free.

As none of these methods was comparable in speed and economy with the oxy-acetylene cutting of plain steel risers, representatives of the oxy-acetylene industry undertook a thorough investigation of the possibility of developing a cutting procedure which would be suitable for chrome-nickel risers. The first work done by the oxy-acetylene cutting process used a steel feeder rod to aid the oxidation process. By this is meant that a steel or iron rod was fed into the kerf while the cut was being made. Obviously this could only be applied to small risers, because it necessitates using the blowpipe with one hand while the rod is fed in by the other. The cuts were slow and thus expensive. The casting is presumed to be on the cleaning floor and the blowpipe must now be made ready. As much heat will be necessary, it is recommended that one size larger nozzle or tip be used than would be the case were the casting of plain steel. The oxygen hose should preferably be ⅜-in. diameter in order to secure ample volume. Tip or nozzle should preferably have six preheating jets rather than the usual four or less. The oxygen cutting pressure needs to be increased perhaps 15 to 20 per cent. more than would be the case were the casting of ordinary steel.

In connection with this cutting, reference is made to experience with an injector type, blowpipe in which the oxygen aspirates sufficient acetylene to maintain a neutral preheating flame. The blowpipe is now adjusted so that the preheating flame will never be oxidising when the cutting jet is wide open. A mere feather of acetylene in the preheating flame is not objectionable; in fact, may be of help to the beginner, but a distinct and heavily-carbonising flame is detrimental to the cutting action in that the preheating temperature is lowered.

From Fig. 1 it will be evident that the cut is started horizontally across the top surface of the riser and that it progresses downward in a vertical plane from the upper surface to the lower. During the cutting the blowpipe is moved up and down.

In starting to cut the operator proceeds to preheat the top of the riser across what is to be his line of cut. It is necessary to do this in order to establish a straight and easy kerf. If this is not done, then there is quite some likelihood of the kerf going "wild" and a pocket forming, with the result that through cutting will stop. When the line of cut has been preheated to a dull red, the operator starts to concentrate his preheat at the point where he will start cutting. Very quickly the spot will become white and start to melt. The blowpipe tip is directed in a horizontal plane across the top. He will now move the blowpipe so that the inner cone of the preheat will be perhaps $\frac{3}{16}$ in. away from the face of the riser, and as he does so turns on the cutting oxygen. If the preheating has been sufficient, the cut will start and the operator will be able to look right into the whole of the kerf and watch his progress. The slag will be much more incandescent than is the case with plain steel, will crackle and spark violently. The operator will, with gentle, but speedy, up-and-down motions, start to bite through the riser. The noise will resemble that occasioned by the rapid sawing of hard wood. He must keep these motions up and down and not swing from side to side, otherwise he will consume too much time and material. He will notice that the cut is not always sustained at the point directly in front of the blowpipe tip. This is probably due to the fact that the cutting oxygen is still cool even after passing through the preheating flame, and this accounts for the suggestion made to keep the inner cone a short distance from the face of the riser. The operator should not stop his work because of this refractory spot, as he will notice that this point will become oxidised and carry off as he goes along, he unconsciously varying the distance between the blowpipe tip and the face of the casting to achieve this result. If the operator stops during a cut and it cools off below red, it will be found somewhat difficult to pick up the cutting smartly, due undoubtedly to the fact that there is now a surface layer of slag added to the kerf. A skilled operator will sever a 6-in. by 6-in. chrome-nickel steel riser in 3 to 3½ min. cutting time, which indicates that there is not a great deal of difference in time between ordinary steel riser cutting and the cutting of the chrome-nickel risers once a man has learned the practice. The kerf made in this cutting is about one-third wider than that of carbon steel of the same diameter. But the cut surface will, of course, not be as smooth as in plain carbon-steel work, because of the need for hand movement in cutting chrome-nickel risers.

The cut can come within reasonable distance of the casting proper. Again, however, judgment must be used in the beginning, for it is far better on the first dozen castings cut to leave a ½-in. stub for finish-grind than to take off the riser to within ¼ in. or $\frac{1}{16}$ in. and chance spoiling the casting through cutting in. Experience will here again show the individual how near he can go.

* A Paper read before the 33rd Annual Meeting of the International Acetylene Association, Philadelphia, Pa., U.S.A., by B. B. Aitchison, of the Oxweld Acetylene Company.

X-Ray Examination of Steel.—According to "Steel," exposure tests have shown that the thickness limit for the satisfactory X-ray examination of steel with the present 300,000-volt equipment is 4¾ in. When tube design will permit operation at higher voltages, this thickness limit will be increased materially and the X-ray examination of steel up to 6 in. in thickness rendered possible.

Annual Competition for Developing the Use of Pig-Iron.

Clause 1.—An annual competition has been promoted by the *Société des Hauts Fourneaux de Saulnes* (Jean Raty & Company) to award prizes for inventions contributing to the development of pig-iron usage.

Clause 2.—Each competitor must send an essay showing in detail the proposed invention and its practical interest, particularly emphasising the importance of his suggestion in extending the use of pig-iron in a new direction. The essay must comprise, on the one hand, information of help to a technologist in his manufacture and, on the other hand, an economic study of the elements of cost price and sales.

Clause 3.—The essays must be typewritten in French, with all the necessary designs and plant attached. They must not contain any indication of the author's identity, but must have a *nom-de-plume*, reproduced elsewhere on a sealed envelope containing the name and address of the author. They must be addressed in duplicate and sent in a registered envelope to the *Centre de Recherches de Fonderie des Hauts Fourneaux de Saulnes*, 18, *Rue La Boétie*, *Paris*, 8*e*.

Clause 4.—For the year 1933 essays will be accepted up to November 30 inclusive; all essays arriving after that date will be excluded. Competitors can at their wish withdraw their essays or modify them up to November 30. After that date they must inform the organisers of the competition of their eventual withdrawal.

Clause 5.—The essays will be judged by a committee, whose decision is final, composed of the following:—*President*, Mr. Léon Guillet. *Committee*: Mr. Marcel Ballay, Mr. Jean Cournot, Mr. Joseph Dharvernas, Mr. Jean Galibourg, Mr. Auguste Le Thomas, Mr. Pierre Nicolau, Mr. Emile Ramas, and Mr. Georges Thevenin.

The above translation is given for the help of our readers, but must not be taken as authoritative.

Last year the prizes were won by Mr. Herry and Mr. Mettauer, of Nancy (about £25) for a Paper on the use of cast iron for the manufacture of tiles and other castings used in the roofing of buildings, and Mr. Simorre, of Angoulême (£12 10s.) for one on metal roads.

Catalogue Received.

Research and Testing Equipment. — The Metropolitan - Vickers Electrical Company, Limited, Trafford Park, Manchester, 17, have sent us a catalogue which is designed to carry a two-fold message. It provides the reader with a picture of the extent of the work accomplished by the great research station the firm has created under the able direction of Mr. A. P. M. Fleming. The second object is to meet a demand which has arisen from visitors to the laboratory themselves desiring to possess some of the unique apparatus which has been devised and installed by the company. Naturally, a laboratory of this character uses vast quantities of apparatus purchasable in the open market, but equally naturally it has designed and built much of a specialised character and of a type not normally available to industry. It is the latter category with which the bulk of the catalogue deals, and which the company in many cases is making available to the world at large. We compliment them on the vision shown, as such a service will help towards a good type of standardisation and eliminate much donkey work by those entering upon new fields of research work. For our readers, the sections on the ascertaining of the strength of material at elevated temperatures and the creep values will be of considerable interest.

XUM

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The Selling of Castings.

By Eric N. Simons.

Wasted Opportunities.

If the author were invited to express in a phrase the secret enemy of all good selling, he would be tempted to reply, "the temptations of routine," and it would be a true answer. There is no greater handicap to all selling than routine. The salesman falls into routine methods, and ceases to bring in *new* business. The sales manager falls into routine in a dozen ways, without ever suspecting it. For it requires something more than an ordinary intelligence to be able to keep permanently fresh and original in thought and action over a long period of years when engaged in selling castings. Once a certain method of getting orders has been established, it tends by that very fact to become a routine, which serves very well until some competitor thinks out a new method. The alert sales manager must, therefore, be constantly driving both his sales force and himself in the direction of new methods, new ideas, new opportunities.

It is interesting to be invited, as the author sometimes is, to cast an eye over the sales organisation of some particular firm. Dozens of good things may be, and often are, being done; but the examination almost always reveals at the same time a large number of wasted opportunities of getting business, and it is with some of these that I propose to deal in this article.

Inquiries Forgotten.

Let us begin with the inquiry for prices. Now there are numerous motives that prompt a firm to send an inquiry to a founder. They may merely want to sound the market. They may be quoting, and only desire the price of a component to enable them to tender. They may be inquiring purely as a matter of form, with the known intention in their minds of placing the order elsewhere. Finally, they may have a direct order to place, and be genuinely seeking a suitable quotation. But whatever the motive for the inquiry, there are certain definite facts that emerge from it which should never be forgotten. These are:—(*a*) The name of the foundry is known to the inquiring firm; (*b*) the inquiring firm is sufficiently interested in the foundry to consult it; (*c*) the inquiring firm knows the foundry product; (*d*) the inquiring firm constitutes a definite market for castings; (*e*) there will be a definite reason of one sort or another either for the placing of the order or for its going past to someone else; and (*f*) from (*e*) can be learned something in regard to the method of obtaining orders from the inquiring firm.

Concerning (*f*), which needs a little elaboration, it should be pointed out that, even if it is ascertained that the order has been placed on price alone, irrespective of quality, something has been learned that may readily serve as a guide for future quotations. It may be that a rather dearer material has been quoted for than could have been supplied. Next time an inquiry is received from that firm, the cheaper material can be quoted for, and there will be a better chance of getting the order. Unless a customer's requirements are familiar, the foundry will naturally tender for the castings it would prefer to supply, and on occasion this may be bad policy. Thus, the inquiry should always be regarded as a definite means of getting better and more accurate information about the customer.

Now, what happens in a good many foundries? The inquiries arrive in their dozens (one hopes). They go to the drawing office. Weights are ascertained and drawings made where necessary. Cost offices calculate and estimating departments analyse the figures, and prepare their quotations as best they can. The quotations go out. The travellers receive their copies. The files receive the works copies. The estimators turn to the next batch of quotations. In other words, routine has set in. If an inquiry is for a good many tons of castings, the sales manager or a director probably takes an interest in it, and worries the salesman into following it up and keeping in touch until the order is settled one way or another. But what has to be remembered is that other sales managers and directors in other foundries are also worrying their salesmen to follow up and keep in touch. Competition is intense.

What of the smaller inquiries? This, unfortunately, is where the opportunities are wasted. Once those quotations have been filed, they are automatically forgotten. Some orders will accrue inevitably. Some might have accrued if routine had not stepped in. All these inquiries would have taught the foundry something; but the filing of those quotations means that that something will never be learned.

What, then, it may be asked, should the foundry do? The salesmen, with all the will in the world, cannot follow up every quotation. They cannot be in sixteen places at once. The estimating department is too busy with its day-to-day work to worry about yesterday's quotations more than it is forced to do. What other home is there for the mounting piles of quotations than the file, where they are safe until needed? Well, the answer is, frankly, the sales department. It is postulated that no inquiry should be filed until everything possible has been done (*a*) to find out whether the order can be attracted; and (*b*) why the order has not been placed with the foundry in question. The proper procedure is for all quotations not needed to be kept out for some reason or other to be forwarded daily to the sales department. There, an official should take charge of them. He should have by him a card index, visible for preference, bearing cards for all the firms sending inquiries; and details of the inquiries—the barest outline, *e.g.*, goods, quantities, price and delivery quoted—should be noted down on these as each inquiry is dealt with. As travellers follow up quotations—they will, of course, follow up a certain number automatically—the result of their efforts will be evident. The orders will either be placed or be refused. The reasons will be extracted from the salesmen's reports and set down on the cards, and then those particular quotations can be filed. At the end of a few days, it will be evident that certain inquiries are not being followed up by the representatives. The quotations should then be followed up by letter from the sales department. This procedure will again draw forth a percentage of reasons either for not placing orders, or for placing the orders. These details will be noted on the cards, and a fresh batch of quotations become filable. The residuum will probably demand a second letter. There will inevitably remain a small number who do not reply.

With this last residuum, the sales department will need to do one or other of two things:—(*a*) Insist that the salesman calls at the first opportunity to find out what has happened to the order, though this call need not be immediate; or (*b*) decide that the inquiry is not important enough to warrant further effort. If (*b*) be decided upon, this does not mean that the quotation will at once be filed. First, the name of the firm inquiring must be noted down as potential customers for the type of casting inquired for. Secondly, their name must be added to circularising lists. Finally, the note that no result followed must be added to the card record. Then, and only then, should the quotation be filed.

The value of this energetic pursuit of inquiries will show itself inevitably in an increase in orders received, since energy always brings some reward, and it is a fact beyond dispute that customers (especially the smaller type) appreciate active efforts to get, and continued, interest in, their business. But the information obtained will also prove of inestimable value as time goes on. When a batch of inquiries is received, it will first pass to the card index, where previous records will be looked up. The official will then note on the inquiry such details as this: "We quoted for 'D' material last time, and lost the order on price"; or "This customer will not pay for patterns. Include cost in quotation. Order received last time at 36s. cwt., which covered cost of patterns"; or "Order lost previously because delivery too long." Receiving these notes, the estimating department has at once a basis on which to operate. It is no longer working in the dark.

It has been suggested that this system should be worked by the sales department, but one can, of course, see obvious objections to the centralisation of inquiry records in a foundry that is highly departmentalised, but there is no irrefragable law about this. If it suits the particular business better, there is no reason whatsoever why these records should not be sectionalised and kept by persons in the departments concerned. What is important is that it should be realised that inquiries are opportunities, and that it should be someone's job to see that these opportunities are not wasted.

Influence of the Slag on Basic Electric-Furnace Cast Iron.

A report by Prof. Piwowarsky and Wilhelm Heinrichs was published in "Archiv für das Eisenhüttenwesen" recently of tests carried out in the foundry of the Löwe-Gesfurel A.G., Berlin, on the changes in chemical composition and physical properties of cast iron refined under different slags in a basic-electric furnace. Observations were made on heats during normal working and also on special experimental heats. The cupola charges were usually 60 per cent. steel, 12½ per cent. of 10 per cent. ferro-silicon, 5 per cent. spiegel with 10 to 12 per cent. Mn and 25 per cent. scrap cast iron. Since the cast-iron scrap was not uniform the cupola iron showed slight variations in silicon content, this being corrected by the addition of 80 per cent. ferro-silicon in the electric furnace. In the experimental heats, ranging from 4 to 5.4 tons, the following first and second slags were used: heat A, both 85 kgs. ground clay; heat B, both 85 kgs. lime; heat C, both 55 kgs. lime, 26 kgs. fluorspar, 13 kgs. coke; heat D, slag 1, 30 kgs. fluorspar, slag 2, 55 kgs. lime, 26 kgs. fluorspar, 13 kgs. coke; heats E and F, both 85 kgs. calcium carbide. In order to prevent the iron being subsequently unusable in castings owing to incorrect refining, heats A, B, E and F were finished under a third slag consisting of 55 kgs. lime, 26 kgs. fluorspar, 13 kgs. coke. Examination of 47 heats using two lime-fluorspar-coke slags showed an average reduction in the silicon and manganese content of the iron of 12 per cent. for both elements, the initial silicon varying between 1.7 and 2.9 per cent. and the manganese from 0.6 to 1.2 per cent.

Transverse tests were made on cast bars 35 mm. dia. by 640 mm. long, from which, after fracture, were cut the pieces for tensile, repeated impact and hardness tests, microscopic examination and estimation of the cavities. Special pieces were cast to determine the tendency to form shrinkage cracks. The results of the tests showed that slags rich in oxygen have a prejudicial effect on the refining of cast iron at high temperatures. Unsuitable slags can even nullify the advantages from superheating the molten metal. Careful attention to the slags is therefore necessary for high-grade cast iron just as for all other casting alloys.

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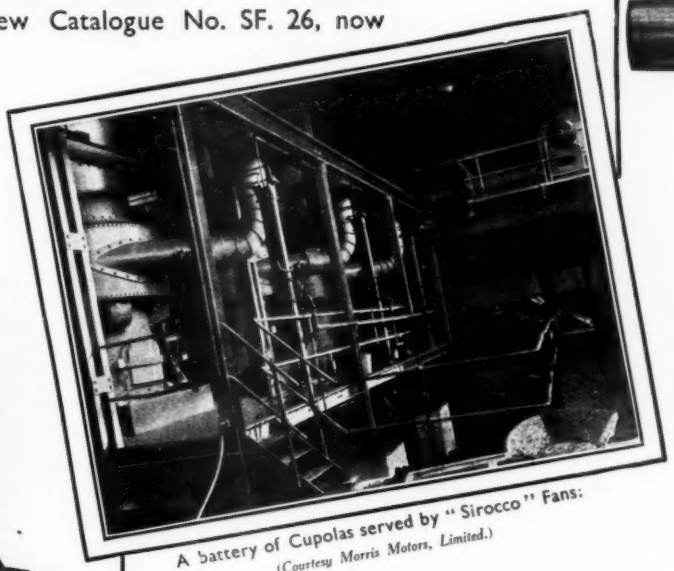

A battery of Cupolas served by "Sirocco" Fans.
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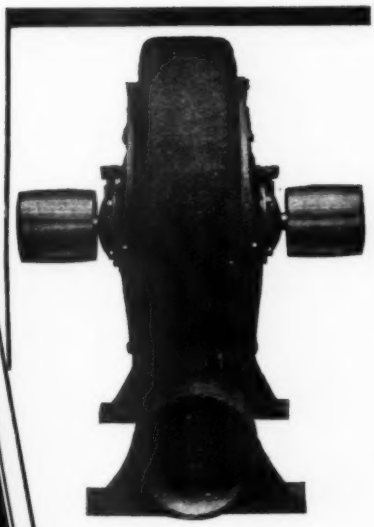

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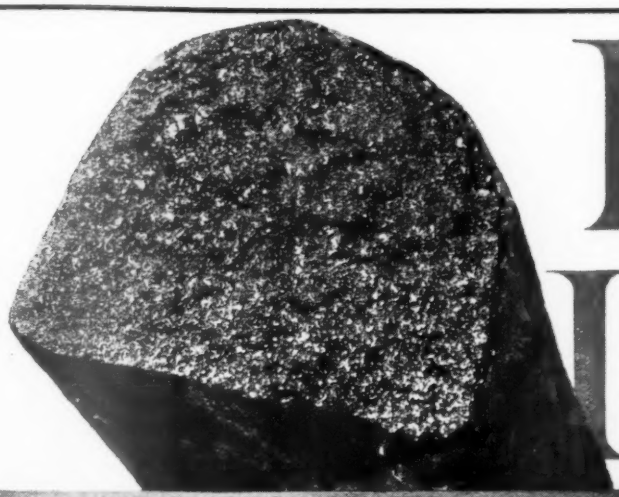

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This Week's News in Brief.

Trade Talk.

Messrs. Scott & Sons, Bowling, Glasgow, have received an order from the Canterbury Shipping Company, of New Zealand, for a coasting motor-ship, 175 ft. in length.

Shipments of pig-iron from Glasgow last week amounted to 670 tons, 60 on foreign account and 610 coastwise. In the corresponding week of last year the figures were 31 and 8 respectively.

Messrs. Dorman, Long & Company, Limited, Middlesbrough, have secured a contract for the supply and erection of 19,000 tons of steelwork for the new power station at Fulham. The work has to be carried out within 39 weeks.

Owing to an improvement in trade, the Consett Iron Company, Limited, is now working five steel furnaces. No. 2 plate mill is working three shifts instead of two, and the guide mill is working two shifts.

The Sunderland shipyard of Short Bros., Limited, is reopening. The firm has received an order for an 8,000-ton cargo vessel. Although only a small number of men will be required at first, it is hoped eventually to employ 700.

The Duke of York, in the course of his industrial tour of Derbyshire, visited the Stanton Ironworks, near Ilkeston, and shook hands with Mr. Sam Page, who has been with the firm for forty-seven years. The Duke drove over some of the company's new iron roads.

Messrs. Fry's Metal Foundries, Limited, have erected a new die-casting foundry adjourning their smelting works at Merton Abbey. The die-casting department, the Hillside Foundry and the Manchester die-casting foundry have been formed into a subsidiary company under the style of Fry's Diecasting, Limited.

The possible development of electric welding in shipbuilding in the Clyde and other areas has induced the Executive Council of the Boilermakers' Society to invite branch secretaries to send particulars of all unemployed welders and the class of work for which they are suited. The Society are preparing a register of welders with a view to supplying the demand for this class of labour in any district.

Mr. Robert C. Stanley, President of the International Nickel Company of Canada, Limited, after an inspection of the Mond Nickel Works at Clydach recently, said that he saw no reason, unless something extraordinary happened, why the Clydach refineries should not continue in operation. The prospects were certainly better than they were a year ago when the works stopped for a period. About 750 men were now employed, and there were hopes of this condition continuing.

Addressing the members of the Tees-side Chamber of Commerce recently, Sir Peter Rylands prophesied a growing consumption of steel in the future. Under normal conditions of consumption the world would be taking to-day at least 100 million tons of steel, and judging by past experience this would increase year by year, so that in another 20 or 30 years the total would be in the region of 140 million tons—double the quantity of steel that was taken to-day. When the solution of the present difficulties was found the demand for steel would be there, and it was only a question of time and circumstances before things were much better than they were to-day.

United Engineers & Founders, Limited, 9, Royal Metal Exchange, Swansea, have recently opened a London office at 9, Victoria Street, Westminster, S.W.1, which represents the interests of four prominent engineering firms of South Wales. Apart from their experience in the construction of complete tinplate and sheet works, they make and machine steel castings up to 25 tons, iron castings up to 40 tons, bronze castings up to 4 tons, steel rolls, grain and chilled-iron rolls within the widest limits, repetition iron castings, mild-steel welded tank and constructional work. They also specialise in iron and steel works' requirements and pickling, scrubbing and cleaning machines for tinplates and sheets. Mr. Dennis Thomas, a director of one of the associated companies—Messrs. Thomas & Clement, Limited—is in charge of their London office.

A new "Great Bell of Bow," weighing 2 tons 12 cwts.—which will be the largest of the peal of 12 bells that have been restored for the famous church of St. Mary-le-Bow, Cheapside—was cast at the Croydon Foundry of Messrs. Gillett & Johnston last Friday. After the molten metal had been run into a cauldron, and before it was tipped into the mould, the Rector of St. Mary-le-Bow, the churchwardens, Alderman Sir Louis Newton, Mr. Gordon Selfridge, who is bearing the cost of reconditioning the bells, the Mayor of Croydon, and others threw silver coins into the metal, "for luck." Before the actual casting the Bishop of Croydon offered dedicatory prayers. When the bells were taken down, five were found to be cracked. These and three others have been recast, and the whole peal, weighing altogether 10½ tons, has been tuned with modern scientific exactitude.

Personal.

Mr. Geoffrey D. Burton has joined the board of the Birmingham Small Arms Company, Limited.

Mr. A. H. Garreau, of the Société Sesci, has changed his address from 6, rue Carmel, Paris, to 10, rue du Sergent, Nanterre, Seine, France.

Mr. A. H. Smethurst, general secretary of the Amalgamated Engineering Union, is retiring in August, when he reaches the Union's age limit of 65 years. Nominations have been invited for the position in succession to Mr. Smethurst.

Col. Alexander McBean, V.D., of Tettenhall, senior partner in the firm of Alexander McBean & Son, iron and steel merchants, Wolverhampton, has been appointed a Deputy Lieutenant of the County of Stafford. Col. McBean, who is well-known in the iron and steel districts, was for 23 years in the 3rd Volunteer Battalion South Staffordshire Regiment, commanding from 1901 to 1906; was gazetted Lieut.-Colonel 6th South Staffordshire Regiment, commanding 1915 to 1917, and raised the National Reserve (1911-1914) in South Staffordshire. He is a Justice of the Peace for Wolverhampton and for the county of Stafford. Other local honours have included the Mayoralty of Wolverhampton, 1897-8.

Company Reports.

Ransomes & Rapier, Limited.—Brought forward, £18,118; profit for 1932, £10,812; dividends of 6 per cent. on the preference shares and 3 per cent. on the ordinary shares; carried forward, £23,414.

British Oxygen Company, Limited.—Final dividend on the ordinary shares of 3 per cent., making 5 per cent. for 1932. In addition a bonus of 1½ per cent. is to be paid out of the balance of undivided profits.

Newton, Chambers & Company, Limited.—Brought forward, £58,743; profit for 1932, £40,825; final dividends on both preference and ordinary shares of 5 per cent., making 7½ per cent. for the year; carried forward, £65,091. During the year an interest was acquired in the Wellman Smith Owen Engineering Corporation, Limited, and three of the directors of Newton, Chambers have joined the board.

General Refractories, Limited.—Gross profit, £13,121; to bad debts reserve account, £1,500; to depreciation account, £2,500; written off reorganisation expenses, £472; written off trade marks, etc., £250; to contingencies and redemption reserve, £2,000; to special reserve for writing down investments and advances, £2,500. The directors do not feel justified in recommending a dividend.

Johnson & Phillips, Ltd.—Profit for 1932, after charging to revenue upwards of £9,000 for maintenance of buildings, plant, etc., £56,455; net profit, after providing for fixed charges and setting aside £11,869 for depreciation, etc., £1,805 pensions and £3,787 income tax, £21,341; brought in, £102,717; to research and development account, £5,000; to dividend equalisation account, £10,000; dividend at the rate of 5 per cent., less tax, on the ordinary shares; carried forward, £99,058.

Obituary.

Sir F. Henry Royce, of Messrs. Rolls-Royce, Limited, of Derby, the motor-car and aeroplane-engine manufacturers, died on Saturday, April 22, at the age of 70. Sir Henry was also a director of Royce, Limited, electrical, mechanical and constructional engineers, of Trafford Park, Manchester.

Company Meeting.

Hadfields, Limited.

The annual meeting of Messrs. Hadfields, Limited, was held in Sheffield on April 20. Sir Robert Hadfield, Bt. (the chairman), who presided, said that the year under review unfortunately not only showed no improvement in the iron and steel industry, but proved to be one of the most difficult and disappointing in the history of the company. There was a further slackening in the demand for its products both at home and abroad, and the consequent intense competition reduced selling prices to a level where they were generally unremunerative. Under such conditions the results shown in the balance sheet had only been reached by constant vigilance over all items of manufacturing cost and general expense. Extensive reorganisations had been made both in the works and in mechanising the methods of costing, accountancy and control, and the company was in a favourable position to take advantage of any improvement in the industrial position. The requirements of the British Government for the last year showed further serious curtailment whether as regards the Army or the Navy. The Government had done its best, nevertheless, to assist them in regard to the limited quantity of work it had to give out. It was to be hoped that before long there would be better things in store for them. If not, then he again repeated the suggestion he made last year, that their firm and others in the same position should receive some reasonable subvention from the Government to help them if they were to continue rendering the best services to the country, that was if not employed to the extent of at least 20 per cent. of their capacity, and also enable them to keep their equipment all ready for full use, which was now done at heavy expenditure on their own part. The chairman referred to the economy effected by the employment of Hadfield "Era" manganese steel in its various applications, and instanced a lay-out on the London & North Eastern Railway, at the Central Station, Newcastle-upon-Tyne, which was put to work on October 30, 1912, and was in use until 1924. The lay-out rendered a total service of about 12 years, whereas the previous construction, made up of carbon-steel rails, gave only four or five years' service, with constant replacements.

New Companies.

Sybry, Searls & Company, Limited.—Capital £100. Steel and iron merchants. Solicitors: Mayo, Elder & Rutherfords, 10, Draper's Gardens, London, E.C.2.

Wilson, Macadam & Company, Limited.—Capital £300. Ironfounders, mechanical engineers, etc. Directors: D. M. Delany, Yarwood Heath, Altrincham, Ches; N. Wilson.

Stanmore, Fox & Company, Limited, 93-5, Charterhouse Chambers, Charterhouse Lane, London, E.C.1.—Capital £1,000. Machinery and metal merchants. Directors: C. J. Fox and A. C. Combe.

S. E. Stout & Sons, Limited.—Capital £1,500. Iron and brass founders. Directors: L. E. E. Stout, 100, Leslie Road, Fallings Park, Wolverhampton; L. A. and L. O. Stout.

John F. Carr & Company (London), Limited, 4, Southampton Row, London, W.C.1.—Capital £2,000. Dealers in iron and ironwork. Directors: W. J. Maskrey and C. A. Parker.

British Coated Sheets, Limited, 12, Grosvenor Gardens, London, S.W.1.—Capital £5,100. Coaters of steel sheets with zinc, tin, brass or alloys thereof. Directors: Sir Maxwell Hicks, Lt. Col. Morgan J. Jones, Sherard Cowper-Coles and T. P. Tapp.

Contracts Open.

Johannesburg, May 12.—Iron or steel valves, for the Rand Water Board. The Department of Overseas Trade. (Reference No. G. 12,438.)

Johannesburg, May 15.—Steel bars to S.A.R. specification C.M.E. 9/1930 and grade A iron to B.S.S. No. 51, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference G.X. 12,491.)

Johannesburg, May 26.—Steam turbines, for the Rand Water Board. The Department of Overseas Trade. (Reference G.X. 12,479.)

Johannesburg, June 2.—Steam pump, for the Rand Water Board. The Department of Overseas Trade. (Reference G.X. 12,480.)

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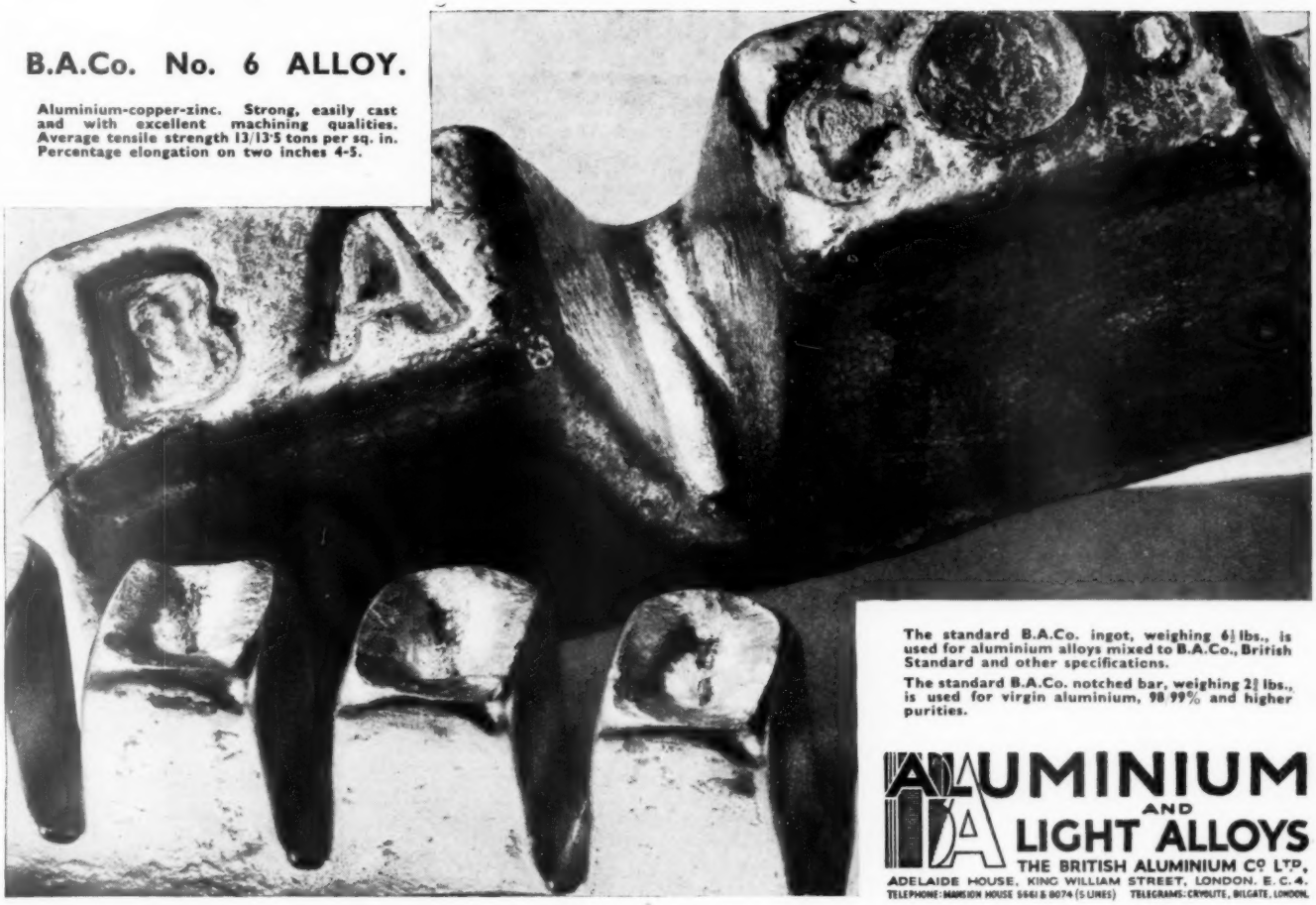

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Raw Material Markets.

New orders for pig-iron have been scarce during the past week, the needs of most consumers being apparently well covered by deliveries under current contracts. There is a moderate demand in the home market for semis and finished steel. Prospects in the export trade have been improved by the negotiation of trade agreements with the Scandinavian countries. The Danish treaty, details of which have been announced, provides for a considerable increase in exports of British iron and steel to Denmark.

A new zone scheme of pig-iron prices for the southern half of England has been arrived at by the Midlands producers and several changes were also made in established rates. Details are given on this page.

Pig-Iron.

MIDDLESBROUGH.—The demand for pig-iron is handicapped by the under-employment at the local foundries and engineering shops. Shipments to Scotland have also been on a slightly smaller scale. In view of the stabilisation of prices, and the presence of abundant supplies of iron, consumers are loth to commit themselves over any long period, and current business is almost entirely for early delivery. There are, however, only two furnaces producing No. 3 G.M.B. for merchanting purposes, and no additions are having to be made to the makers' stocks. For No. 3 Cleveland G.M.B., foundry grade, the fixed prices are:—Delivered Middlesbrough area, 62s. 6d.; delivered Glasgow, 62s. 9d.; delivered North-East Coast, 64s. 6d. There is a premium of 2s. 6d. for No. 1 Cleveland foundry iron, and 1s. per ton is deducted when No. 4 foundry or No. 4 forge iron is required.

Heavy deliveries of East Coast hematite have been made in recent weeks to South Wales and Sheffield, but export business is difficult to secure, and the disposal of the output is giving the makers considerable anxiety. Mixed numbers are quoted at 59s. and No. 1 quality at 59s. 6d. per ton. Although there is no control over merchants' transactions, there has been very little undercutting in this direction.

LANCASHIRE.—Increased activity is reported at some of the speciality foundries in the Lancashire area, but the jobbing section is generally short of work. On the whole, the volume of pig-iron orders has slightly increased, contracts for forward delivery being somewhat less scarce. The general price position has been fully maintained, with Midland brands of No. 3—Derbyshire and Staffordshire—quoted on the basis of 67s. per ton for delivery to consumers in the Manchester zone, North-East Coast iron being nominally at about the same figure, Northamptonshire at 65s. 6d., Derbyshire forge at 62s., Scottish foundry at around 82s., and East and West Coast hematite iron at 75s. 6d. and 80s. 6d. per ton, respectively.

MIDLANDS.—New business is limited, but deliveries against contracts are maintained at a steady rate. Prices are unaltered at 62s. 6d. for Northants No. 3 and 66s. per ton for North Staffordshire, Derbyshire and Lincolnshire No. 3, including delivery to Birmingham and Black Country stations. The Cleveland makers are sending small tonnages of their No. 3 iron into this district at 66s. per ton. Continental foundry iron is quite uncompetitive in the Midlands. There has been no alteration in the prices of Scottish iron, which comes through into this area in moderate quantities at between 83s. and 85s. per ton. Medium-phosphorus iron from other districts is offered at between 70s. and 85s. delivered. West Coast hematite remains at 84s. 6d. for No. 3, which is a controlled price, but prices for Welsh and East Coast iron are not under any control and vary from 74s. to 77s. 6d., according to analysis and tonnage.

SCOTLAND.—Business is very restricted. Owing to the fixed-price system, the foundries are buying only as the need arises. There is no change in the official minimum of 65s. f.o.t. furnaces for No. 3 Scottish foundry iron, with a minimum of 2s. 6d. extra for No. 1. Prices of Cleveland iron are unaltered at 59s. 9d. f.o.t. Falkirk and 62s. 9d. f.o.t. Glasgow for No. 3 Middlesbrough, with No. 4 foundry at 1s. per ton less.

Coke.

Conditions in the foundry-coke market are generally uninteresting. Consumers still pursue a hand-to-mouth policy when buying, and their total requirements are very restricted. Best quality Durham coke is quoted at 36s. 6d. to 38s. 6d. per ton, with other grades at 2s. 6d. less, and Welsh fuel is quoted at between 30s. and 46s. per ton, all delivered in the Birmingham district.

Steel.

More active conditions have developed in the steel markets as the first disturbing effects of the American crisis have passed. Export buyers, after holding aloof from the market for a time, have shown more interest, and not only has there been a considerable volume of inquiry, but a fair amount of actual business has been transacted. Business in the semi-finished steel market has been quiet. The advance in Continental quotations for this description of steel, combined with the movement of the exchange, has made sales in the British market impossible. On the other hand, buying from the British producers has been principally confined to small lots for near delivery. A slight improvement in the demand for finished steel is noticeable. The recent shipbuilding contracts are now being reflected in orders for steel. The export trade also has become rather brighter.

Scrap.

The scrap-iron market is very dull at the moment, few consumers being in need of fresh supplies, and prices are generally weak. In the Cleveland district there is little call for machinery quality at 40s. and for ordinary metal at the same price, both being in plentiful supply. There is, however, a steady demand from Midlands foundries, quotations being 45s. to 47s. 6d. for heavy machinery metal in cupola sizes, 42s. 6d. for good heavy pipe and plate scrap, and 37s. 6d. for clean, light cast iron. Plentiful supplies of scrap iron are available in South Wales. Heavy cast iron in large pieces and furnace sizes is quiet at 43s. 6d. to 44s. 6d. Machinery scrap is in limited demand at 48s. to 50s., light cast being at 38s. to 39s. In Scotland, machinery scrap is easier, at 49s. to 50s. for first-class material, ordinary cast being at about 46s. 6d.

Metals.

Copper.—London copper quotations have remained very steady, although prices in the United States have been fluctuating widely. Consumers both in this country and on the Continent have been showing little interest, and activity has been mainly on speculative account. At the end of last week there was a considerable call for prompt metal, followed by a marked contraction in the contango. The situation in America continues to exercise a disturbing influence on market sentiment.

The week's prices have been as follow:—

Cash.—Thursday, £30 13s. 9d. to £30 16s. 3d.; Friday, £30 10s. to £30 11s. 3d.; Monday, £30 18s. 9d. to £31; Tuesday, £31 3s. 9d. to £31 5s.; Wednesday, £31 5s. to £31 6s. 3d.

Three Months.—Thursday, £30 16s. 3d. to £30 17s. 6d.; Friday, £30 12s. 6d. to £30 13s. 9d.; Monday, £31 to £31 1s. 3d.; Tuesday, £31 5s. to £31 6s. 3d.; Wednesday, £31 7s. 6d. to £31 8s. 9d.

Tin.—The market has been active. Prices have advanced steadily, apart from occasional setbacks due to profit-taking. It is announced that the agreement to curtail exports to 33⅓ per cent. of capacity from July 1 has now been confirmed by the International Tin Committee. Shipments have been at the rate of 40 per cent. during the last ten months. This action has caused considerable criticism, in view of the fact that current consumption has been considerably in excess of production. A further rise in price would seem to be inevitable under the new conditions. This would, of course, be a considerable handicap to the manufacturer, while the producers themselves are finding the carrying out of the scheme very difficult. The holders of pool tin would seem to be the only section likely to benefit. The end-of-the month statistics displayed a decrease in world visible supplies of 1,795 tons, as compared with the position on March 31, thus placing the market in a strong position.

Daily quotations:—

Cash.—Thursday, £164 10s. to £164 12s. 6d.; Friday, £164 7s. 6d. to £164 10s.; Monday, £171 to £171 5s.; Tuesday, £173 7s. 6d. to £173 10s.; Wednesday, £173 15s. to £174.

Three Months.—Thursday, £165 2s. 6d. to £165 5s.; Friday, £165 to £165 2s. 6d.; Monday, £171 12s. 6d. to £171 17s. 6d.; Tuesday, £174 to £174 2s. 6d.; Wednesday, £174 7s. 6d. to £174 10s.

Spelter.—There has been a fairly large volume of business in spelter on the London market, and the price remained fairly steady until last Thursday, when large quantities were offered, and the price fell by about 5s. per ton, state Messrs. Brandeis, Goldschmidt & Company. The undertone of the market is quite good and there is a steady demand both in England and on the Continent for the higher grades of spelter. However, the inquiry from the galvanising trade has been less satisfactory of late. In the U.S. conditions are still unsettled, but the sharp advance which took place last week appears to have been too sudden and the price—after advancing to 3.75 cents—has again been reduced to 3.65 cents at St. Louis.

Price fluctuations:—

Ordinary.—Thursday, £15 3s. 9d.; Friday, £15 1s. 3d.; Monday, £14 16s. 3d.; Tuesday, £14 18s. 9d.; Wednesday, £14 16s. 3d.

Lead.—It is generally reported that there is an excellent demand from manufacturers for this metal. Hence it is encouraging to note that consumers are not being forced to pay an exorbitant price for their metal, and that plentiful supplies are forthcoming when required.

Daily market prices:—

Soft Foreign (Prompt).—Thursday, £11; Friday, £11 1s. 3d.; Monday, £10 18s. 9d.; Tuesday, £11 1s. 3d.; Wednesday, £11 1s. 3d.

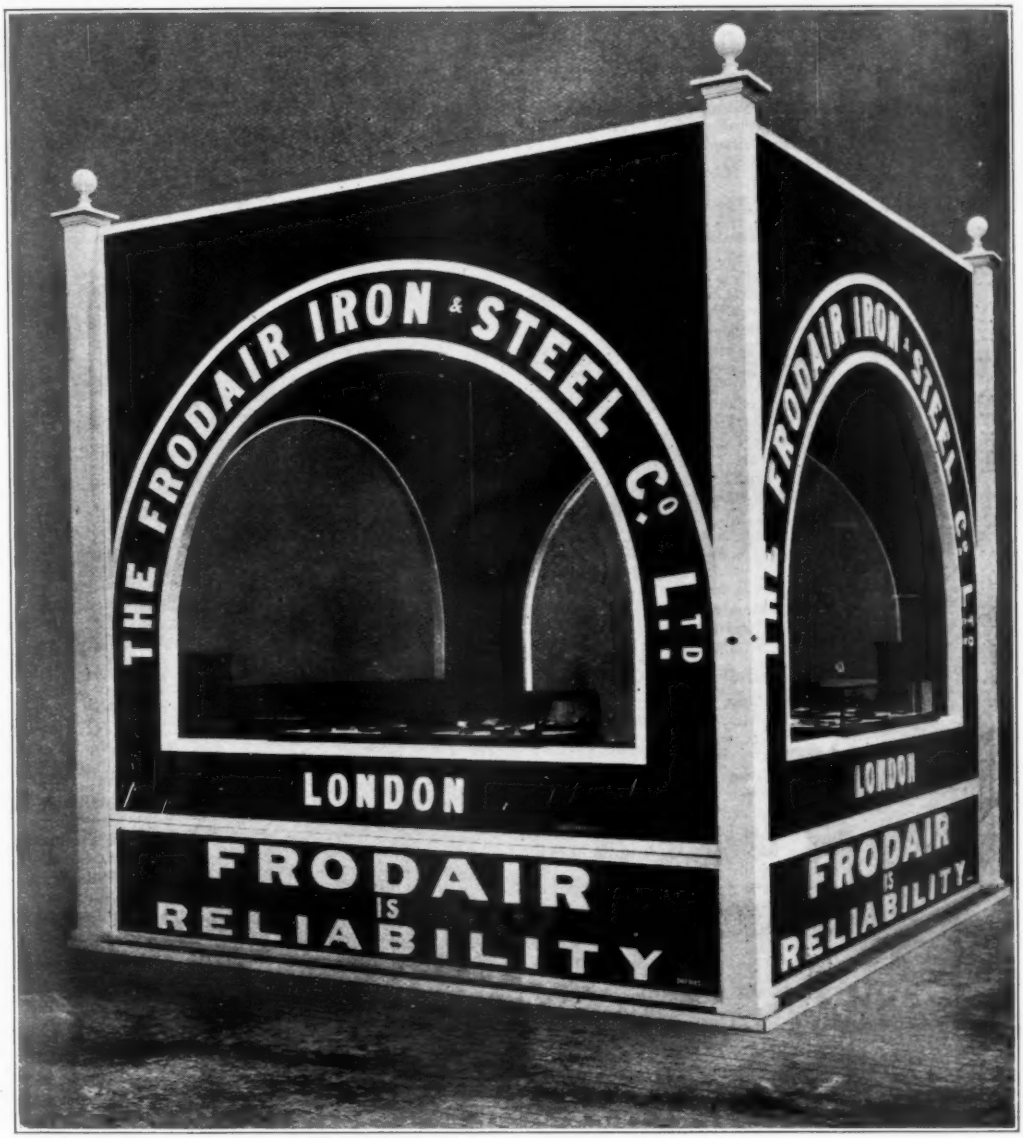
Midland Pig-Iron Prices.

CHANGES IN ZONE RATES.

The Central Pig-iron Producers' Association, meeting at Stoke-on-Trent last Thursday, advanced their prices for several centres in the North of England, and also mapped out the Southern area into five zones, to each of which fixed minimum selling prices will apply in the same way as control operates in the North and Midlands. The advances made were as follow:—Zone One: Burnley, Preston and Blackburn, from 67s. to 69s.; Zone Two: Bradford, Halifax, Shipley, etc., from 65s. to 66s. and Leeds from 63s. 6d. to 66s.; Zone Three: Bolton, Bury, Wigan, etc., from 67s. to 68s. for Derbyshire No. 3 foundry. Prices for Northamptonshire No. 3 foundry are 1s. 6d. less than those for Derbyshire. In two Northern zones and in the Midlands the former prices have been reaffirmed. In South Wales and the West of England, where the control has been suspended in order to give furnacemen a free hand in meeting foreign competition, the same arrangement is to continue.

In the Southern half of England the following prices have been fixed for the newly constituted zones:—King's Lynn, March and Ely district, 66s.; for the zone between that district and the Thames, 70s.; for another zone more accessible, 66s.; in the district south of the Thames, 72s.; in the Southern belt as far as Bournemouth, 72s. In these zones Northamptonshire No. 3 is 3s. 6d. below the Derbyshire prices.

World Power Conference, Sectional Meetings, 1933.—Bulletin No. 4 has been published by the organising committee of this year's sectional meeting of the World Power Conference, at Stockholm, and contains the final programme. The arrangements have undergone slight modification from those originally announced. The opening reception takes place in Copenhagen on Monday, June 26, 1933, at 1 o'clock: the official opening in Stockholm on Wednesday, June 28, at noon—all the Technical Sessions will be held in Stockholm. The Norwegian part of the programme begins on Friday, July 7, and the final proceedings in connection with the Conference will take place in Oslo on Saturday, July 8. Copies of Bulletin No. 4, as well as of the previous numbers, may be obtained from the British National Committee, who are now able to supply forms of application for membership of the Conference.



Special Pigiron

BEST AFTER TEST

for

50 YEARS.

FRODAIR IRON & STEEL Co. Ltd.

FENCHURCH HOUSE, LONDON.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	31	5	0
Three months	31	7	6
Electrolytic	35	5	0
Tough	33	0	0
Best selected	33	10	0
Sheets	61	0	0
India	44	0	0
Wire bars	35	10	0
Do., May	35	15	0
Do., June	36	0	0
Ingot bars	35	10	0
H.C. wire rods	37	10	0
Off. av. cash, April	29	12	5⅛
Do., 3 mths., April	29	16	6¾
Do., Sttlmnt., April	29	12	9⅛
Do., Electro, April	33	19	4½
Do., B.S., April	32	14	4½
Do., wire bars, April	34	5	1⅝
Solid drawn tubes			9½d.
Brazed tubes			9½d.
Wire			6½d.

BRASS.

Solid drawn tubes	8¾d.
Brazed tubes	10¾d.
Rods, drawn	7⅝d.
Rods, extd. or rlld.	4¾d.
Sheets to 10 w.g.	7½d.
Wire	7⅜d.
Rolled metal	7d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5¼d.

TIN.

	£	s.	d.
Standard cash	173	15	0
Three months	174	7	6
English	175	5	0
Bars	177	12	6
Straits	186	7	6
Australian	181	15	0
Eastern	184	12	6
Banca	182	15	0
Off. av. cash, April	158	0	4⅕
Do., 3 mths., April	158	15	1⅘
Do., Sttlmt., April	158	0	3⅗

SPELTER.

	£	s.	d.
Ordinary	14	16	3
Remelted	15	0	0
Hard	12	10	0
Electro 99.9	17	7	6
English	15	15	0
India	14	0	0
Zinc dust	18	15	0
Zinc ashes	2	5	0
Off. aver., April	15	1	7⅛
Aver. spot, April	14	19	0⅛

LEAD.

	£	s.	d.
Soft foreign ppt.	11	1	3
Empire	11	6	3
English	12	10	0
Off. average, April	10	19	11⅛
Average spot, April	10	17	5⅛

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	0	0
Do., V.M. ex-whse.	23	5	0
Rods	26	0	0
Boiler plates		—	
Battery plates		—	

ANTIMONY.

	£	s.	d.	£	s.	d.
English	37	10	0 to	42	10	0
Chinese				27	0	0
Crude					—	

QUICKSILVER.

	£	s.	d.	£	s.	d.
Quicksilver	8	0	0 to	9	5	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon—	
25%	£7 15 0
45/50%	£13 17 6
75%	£19 12 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10d. lb.
Ferro-phosphorus, 20/25%	£17 17 6
Ferro-tungsten—	
80/85%	1/6 lb.
Tungsten metal powder—	
98/99%	1/9 lb.
Ferro-chrome—	
2/4% car.	£29 5 0
4/6% car.	£22 15 0
6/8% car.	£21 15 0
8/10% car.	£21 0 0
Ferro-chrome—	
Max. 2% car.	£33 10 0
Max. 1% car.	£36 5 0
Max. 0.70% car.	£40 2 6
70%, carbon-free	11d. lb.
Nickel—99.5/100%	£240 to £245
"F" nickel shot	£216 0 0
Ferro-cobalt	7/3 lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel				2	3	6
Bundled steel and shrngs.	1	17	6 to	2	0	0
Mixed iron and steel	2	0	0 to	2	1	0
Heavy cast iron	2	3	6 to	2	4	6
Good machinery	2	8	0 to	2	10	0
Cleveland—						
Heavy steel				1	15	0
Steel turnings				1	11	6
Cast-iron borings				1	2	0
Heavy forge				2	10	0
W.I. piling scrap				2	2	6
Cast-iron scrap				2	0	0
Midlands—						
Light cast-iron scrap				1	17	6
Heavy wrought iron				2	7	6
Steel turnings, f.o.r.				1	4	6
Scotland—						
Heavy steel	1	17	6 to	1	18	6
Ordinary cast iron				2	6	6
Engineers' turnings				1	11	6
Cast-iron borings				1	12	6
Wrought-iron piling				2	2	6
Heavy machinery	2	9	0 to	2	10	0
London—Merchants' buying prices, delivered yard.						
Copper (clean)				23	0	0
Brass				16	0	0
Lead (less usual draft)				9	10	0
Tea lead				8	0	0
Zinc				9	0	0
New aluminium cuttings				74	0	0
Braziery copper				19	0	0
Gunmetal				20	0	0
Hollow pewter				90	0	0
Shaped black pewter				70	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/-
Foundry No. 3	62/6
,, at Falkirk	59/9
,, at Glasgow	62/9
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	59/6
Hematite M/Nos., f.o.t.	59/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	68/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/-
,, No. 3 fdry.	66/-
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/-
,, fdry. No. 3	66/-
,, fdry. No. 1	69/-
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/-
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/-
Clyde, No. 3	82/-
Monkland, No. 3	82/-
Summerlee, No. 3	82/-
Eglinton, No. 3	82/-
Gartsherrie, No. 3	82/-
Shotts, No. 3	82/-

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	7	10	0 to	8	0	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				12	15	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.				8	5	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ⅜ in. (Untested)	6	15	0 & up.			
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)	9	10	0 & up.			
Black sheets, 24g. (10-t. lots)	9	10	0			
Galv. cor. shts. ,,	11	15	0			
Galv. flat shts. ,,	12	5	0			
Galv. fencing wire, 8g. plain	14	0	0			
Billets, soft	5	0	0 to	5	7	6
Billets, hard	6	12	6 to	7	2	6
Sheet bars	4	15	0 to	5	2	6
Tin bars				4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11⅜d.
Rods	10½d.
Tubes	15d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	14.34
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.50
Sheets, black, No. 24	2.00
Sheets, galv., No. 24	2.60
Wire nails	1.85
Plain wire	2.10
Barbed wire, galv.	2.35
Tinplates, 100-lb. box	$4.25

COKE (at ovens).

Welsh foundry	20/- to 22/6
,, furnace	16/- to 17/-
Durham and Northumberland—	
,, foundry	21/- to 25/-
,, furnace	13/3
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	16/- to 16/6	
,,	28×20 ,,	32/- to 33/-	
,,	20×10 ,,	23/- to 24/-	
,,	18¾×14 ,,	—	
C.W.	20×14 ,,	14/6 to 15/-	
,,	28×20 ,,	—	
,,	20×10 ,,	—	
,,	18¾×14 ,,	—	

SWEDISH CHARCOAL IRON & STEEL.

	£	s.	d.	£	s.	d.
Pig-iron	£6	0	0 to	£7	0	0
Bars-hammered, basis	£16	10	0 to	£17	0	0
Bars and nail-rods, rolled, basis	£15	17	6 to	£16	5	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£32	0	0 to	£33	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

XUM

DAILY FLUCTUATIONS.

Standard Copper (cash).

			£	s.	d.	
April	27	..	30	13	9 dec.	1/3
,,	28	..	30	10	0 ,,	3/9
May	1	..	30	18	9 inc.	8/9
,,	2	..	31	3	9 ,,	5/–
,,	3	..	31	5	0 ,,	1/3

Electrolytic Copper.

			£	s.	d.	
April	27	..	35	5	0 inc.	5/–
,,	28	..	35	0	0 dec.	5/–
May	1	..	34	10	0 ,,	10/–
,,	2	..	35	0	0 inc.	10/–
,,	3	..	35	5	0 ,,	5/–

Standard Tin (cash).

			£	s.	d.	
April	27	..	164	10	0 inc.	10/–
,,	28	..	164	7	6 dec.	2/6
May	1	..	171	0	0 inc.	132/6
,,	2	..	173	7	6 ,,	47/6
,,	3	..	173	15	0 ,,	7/6

Tin (English ingots).

			£	s.	d.	
April	27	..	165	15	0 inc.	7/6
,,	28	..	165	15	0 No change	
May	1	..	172	5	0 inc.	130/–
,,	2	..	174	15	0 ,,	50/–
,,	3	..	175	5	0 ,,	10/–

Spelter (ordinary).

			£	s.	d.	
April	27	..	15	3	9 dec.	2/6
,,	28	..	15	1	3 ,,	2/6
May	1	..	14	16	3 ,,	5/–
,,	2	..	14	18	9 inc.	2/6
,,	3	..	14	16	3 dec.	2/6

Spelter (Electro, 99.9 per cent.).

			£	s.	d.	
April	27	..	17	15	0 No change	
,,	28	..	17	10	0 dec.	5/–
May	1	..	17	5	0 ,,	5/–
,,	2	..	17	7	6 inc.	2/6
,,	3	..	17	7	6 No change	

Zinc Sheets (English).

			£	s.	d.	
April	27	..	24	0	0	No change
,,	28	..	24	0	0	,, ,,
May	1	..	24	0	0	,, ,,
,,	2	..	24	0	0	,, ,,
,,	3	..	24	0	0	,, ,,

Lead (English).

			£	s.	d.	
April	27	..	12	10	0	No change
,,	28	..	12	10	0	,, ,,
May	1	..	12	10	0	,, ,,
,,	2	..	12	10	0	,, ,,
,,	3	..	12	10	0	,, ,,

AVERAGE MONTHLY PRICES OF STEEL SHIP ANGLES (NORTH OF ENGLAND).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1898	5 5 0	5 5 0	5 5 0	5 7 6	5 13 9	5 15 0	5 15 0	5 15 0	5 17 6	6 0 0	6 5 0	6 7 6	5 14 3
1899	6 10 0	6 12 6	6 15 0	6 15 0	6 17 6	6 17 6	7 0 0	7 0 0	7 5 0	7 5 0	7 12 6	7 15 0	7 0 5
1900	7 15 0	8 0 0	8 2 6	8 5 0	8 5 0	8 7 6	8 7 6	8 2 6	8 2 6	8 0 0	7 10 0	7 10 0	8 0 7½
1901	6 15 0	6 12 6	6 5 0	6 0 0	6 0 0	5 10 0	5 15 0	5 17 6	6 0 0	5 17 6	5 17 6	5 15 0	6 0 5
1902	5 12 6	5 10 0	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 11 8
1903	5 6 3	5 6 3	5 7 6	5 12 6	5 12 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 0 0	5 8 9
1904	5 0 0	4 17 6	5 2 6	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 0 0	5 0 0	5 0 0	5 5 0	5 2 6
1905	5 5 0	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 12 6	6 2 6	6 12 6	6 12 6	5 14 4½
1906	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	7 2 6	6 18 4
1907	6 17 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	6 12 6	6 12 6	7 0 5
1908	6 2 6	6 2 6	6 2 6	5 17 6	5 17 6	5 17 6	5 17 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 16 3
1909	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 9 7
1910	5 16 3	5 17 6	5 17 6	6 1 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 7 6	6 7 6	6 7 6	6 2 3½
1911	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 9 0	6 7 8½
1912	6 16 3	6 17 6	6 17 6	7 5 0	7 7 6	7 7 6	7 7 6	7 12 6	7 12 6	7 12 6	7 14 6	7 17 6	7 7 4½
1913	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 11 6	7 7 6	6 15 6	6 7 6	6 2 6	7 8 11½
1914	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	5 15 0	5 15 0	6 15 0	7 0 0	7 0 0	7 1 3	7 5 0	6 8 7½
1915	7 17 0	8 5 0	8 17 6	9 5 0	9 5 0	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0	10 15 0	10 15 0	9 8 8½
1916	11 3 1½	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1917	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1918	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1919	11 2 6	13 12 6	13 12 6	13 12 6	17 2 6	17 1 3	17 0 0	17 15 0	17 15 0	17 15 0	17 17 6	18 5 0	16 1 9
1920	19 10 0	20 0 0	21 10 0	22 0 0	23 5 0	24 0 0	24 0 0	24 0 0	24 15 0	24 10 0	24 0 0	24 0 0	22 19 2
1921	22 10 0	20 12 6	19 0 0	17 10 0	17 10 0	16 6 0	14 10 0	14 3 4	13 10 0	11 15 0	10 0 0	9 12 6	15 11 7
1922	9 17 6	10 0 0	10 0 0	10 0 0	10 0 0	9 17 6	9 10 0	8 15 7½	8 14 0	8 12 6	8 12 6	8 12 6	9 7 8½
1923	8 18 1½	9 1 3	9 14 0	10 0 0	10 0 0	10 0 0	9 8 9	9 9 6	9 10 0	9 8 9	9 11 6	9 18 9	9 11 8½
1924	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 2	9 11 3	9 15 0	9 15 0	9 9 4½	9 6 6	9 5 0	9 5 0	9 13 1½
1925	9 2 0	9 0 11½	9 0 0	8 15 9	8 10 3½	8 9 0½	8 6 3	8 2 6	7 19 0½	7 12 3	7 5 0	7 2 6	8 5 5½
1926	7 2 6	7 2 6	7 2 6	7 3 4	7 2 6	7 3 9	7 7 6	7 8 5½	7 9 0	7 12 6	7 16 3	8 0 6	7 7 7½
1927	7 18 9	7 17 6	7 17 6	7 14 8½	7 13 9	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 14 1½
1928	7 12 6	7 14 9	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 16 10½
1929	7 17 6	7 17 6	7 17 6	7 17 6	8 0 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 5 0	8 0 10½
1930	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1931	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1932	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1933	8 7 6	8 7 6	8 7 6	8 7 6	—	—	—	—	—	—	—	—	—

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